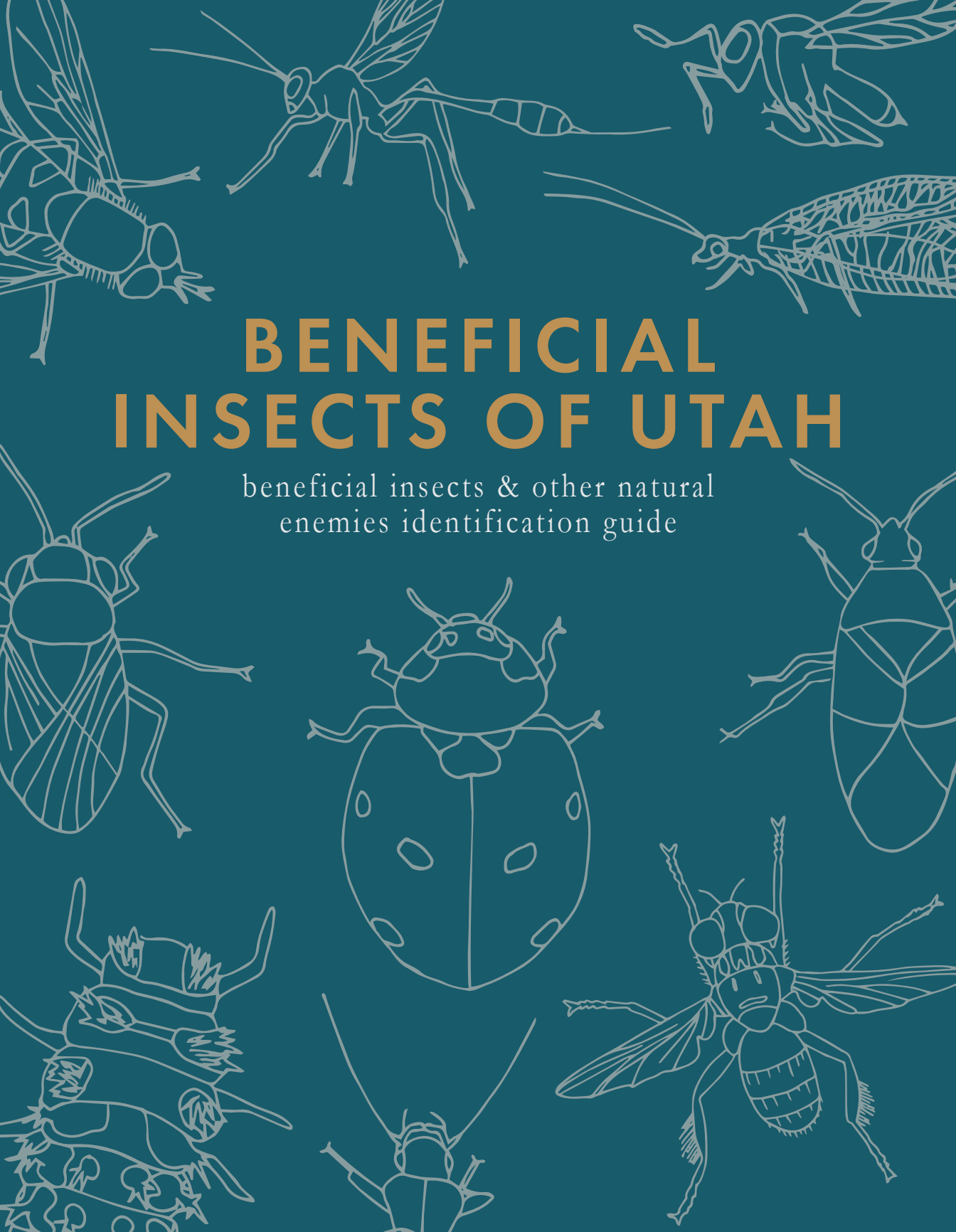

BENEFICIAL INSECTS OF UTAH

beneficial insects & other natural enemies identification guide

EXTENSION
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IMAGE CREDITS

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CONTENTS

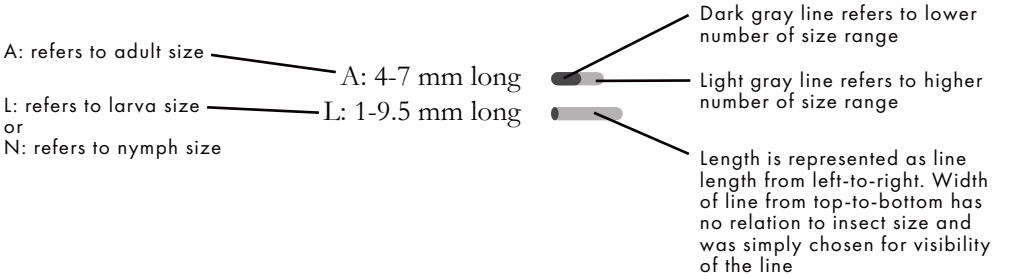
PREFACE

How to Use this Guide

This guide is organized by specific natural enemies within the following groups:

- Predators
- Parasites
- Pathogens
- Nematodes

Each beneficial insect page lists the approximate size range of adults and sometimes nymphs or larvae and should be interpreted as follows:



Purpose of this Guide

Although great in number and hard at work in agricultural and landscape systems, beneficial insects are often overlooked and can be overshadowed by the comparatively small number of insect pests. Only about 1% of all insects and mites are harmful. With some look-alike insects and heightened concern for pest populations, there is potential to wrongly label a beneficial as a pest. This guide was developed to help properly identify Utah's natural enemies and raise awareness of ways to attract and conserve them.

Importance of Beneficial Insects and Other Natural Enemies

Biological control (or biocontrol) is the beneficial action of predators, parasites, and pathogens in managing pests and preventing their damage. These natural enemies play an important role in an overall IPM (integrated pest management) program, with potential to keep pest populations below economic thresholds. Natural biocontrol may provide several benefits such as:

- An alternative to pesticides and therefore a reduction in pesticide use
- Saving in pesticide costs
- Reduced risk of chemical residues on farm products
- Non-chemical options for targeted attack on specific pests
- Low costs for high benefits
- Reduction of negative impacts caused by endemic pests
- Lowering the chances of insect pests developing resistance to insecticides.

General Practices to Enhance Beneficial Insect/Natural Enemy Populations

There are several specific ways to attract and conserve beneficial insects, which are discussed throughout the guide for each insect. Listed below are general practices to help enhance beneficial insect populations:

- Reduce pesticide use
- Switch to insecticides that target only specific pests
- Provide nectar and pollen to support predators and parasitoids that use this as food
- Enhance the habitat with a variety of plants that bloom throughout the growing season (this can provide nectar and pollen as well as alternate prey, egg-laying, and overwintering shelter for beneficial insects).

Plants that will Enhance Beneficial Insect Populations

The following is a list of plants that help enhance biodiversity by attracting and helping to conserve natural enemies. This list was adapted from the online publication from ATTRA, Farmscaping to Enhance Biological Control by Rex Dufour. Refer to the online publication for more details by searching the internet for "ATTRA farmscaping to enhance biological control".

Plants to Attract and Conserve Beneficial Insects

Beneficial	Plants to attract/conserve
Aphid predatory midge (*Aphidoletes* spp.)	Dill, mustard, thyme, sweet clover
Assassin bug (Reduviidae family)	Permanent plantings for shelter (e.g., hedgerows)
Big-eyed bugs (*Geocoris* spp.)	Cool-season cover crops such as berseem clover (*Trifolium alexandrium*), and subterranean clovers (*Trifolium subterraneum*). Can be found on common knotweed (*Polygonum aviculare*) as well.
Braconid wasp (Braconidae family)	Nectar plants with small flowers (caraway, dill, parsley, Queen Anne's lace, fennel, mustard, white clover, tansy, yarrow), sunflower, hairy vetch, buckwheat, cowpea, common knotweed, crocuses, spearmint.
Damsel bug (Nabidae family)	Sunflower family plants, goldenrod, yarrow, alfalfa.
Ground beetle (Carabidae family)	Permanent plantings, amaranth, white-clover in orchards, mulch.

Plants to Attract and Conserve Beneficial Insects (continued)

Beneficial	Plants to attract/conserve
Lacewings, dustywings	Carrot family (caraway, Queen Anne's lace, tansy, dill, angelica), sunflower family (coreopsis, cosmos, sunflowers, dandelion, goldenrod), buckwheat, corn, holly leaf cherry (*Prunus ilicifolia*), flowering bottle tree (*Brachychiton populneum*), soapbark tree (*Quillaja saponaria*). Provide water during dry spells.
Lady beetle /ladybug/ ladybird beetle	Carrot family (fennel, angelica, dill, tansy, bishop's weed (*Ammi* spp.), Queen Anne's lace), sunflower family (goldenrod, coreopsis, cosmos, golden marguerite (*Anthemis* spp.), dandelion, sunflower, yarrow), crimson clover, hairy vetch, grains and native grasses, butterfly weed (*Asclepias* spp.), black locust, buckwheat, euonymus, rye, hemp, sesbania (*Sesbania exaltata*), soapbark tree, buckthorn (*Rhamnus* spp.), saltbush (*Atriplex* spp.), black locust (*Robinia pseudoacacia*).
Minute pirate bug (*Orius* spp.)	Carrot family (Queen Anne's lace, tansy, coriander, bishop's weed, chervil), sunflower family (cosmos, tidy tips (*Layia* spp.), goldenrod, daises, yarrow), baby-blue-eyes (*Nemophila* spp.), hairy vetch, alfalfa, corn, crimson clover, buckwheat, blue elderberry (*Sambucus caerulea*), willows, shrubs.
Parasitic nematodes	Marigolds, chrysanthemum, gaillardia, helenium, *Eriophyllus lanatum*, horseweed, hairy indigo, castor bean, *Crotalaria* spp., *Desmodium* spp., sesbania, mexicantea (*Chenopodium ambrosioides*), shattercane (*Sorghum bicolor*), lupine, *Phaseolus atropurpurens*.
Parasitoid wasp on aphid (*Aphidius* spp.)	Nectar plants with small flowers (anise, caraway, dill, parsley, mustard family, white clover, Queen Anne's lace, Yarrow).
Praying Mantis /mantid / praying mantid	Cosmos, brambles.

Plants to Attract and Conserve Beneficial Insects (continued)

Beneficial	Plants to attract/conserve
Rove beetle (Staphylinidae family)	Permanent plantings; inter-plant strips of rye, grains, and cover crops; mulch beds; make stone or plant walkways in garden to provide refuges.
Spiders	Caraway, dill, fennel, cosmos, marigold, spearmint.
Spider mite destroyer (*Stethorus* spp.)	Carrot family (dill, fennel, etc.), mustard family (sweet alyssum, candytuft, etc.).
Spined soldier bug (*Podisus maculiventris*)	Sunflower family (goldenrod, yarrow), bishop's weed; Maintain permanent plantings.
Syrphid fly (Hover flies) (Syrphidae family)	Carrot family (Queen Anne's lace, dill, fennel, caraway, tansy, parsley, coriander, bishop's weed), the sunflower family (coreopsis, gloriosa daisy, yarrow, cosmos, sunflower, marigolds), candytuft, sweet alyssum, ceanothus, holly-leaved cherry (*Prunus ilicifolia*), buckwheat, scabiosa, spearmint, coyote brush (*Baccharis pilularis*), knotweed (*Polygonum aviculare*), California lilacs (*Ceanothus* spp.), soapbark tree, meadow foam (*Linnanthes douglasii*), baby-blue-eyes (*Nemophila* spp.).
Tachinid fly (Tachinidae family)	Carrot family (caraway, bishop's weed, coriander, dill, parsley, Queen Anne's lace, fennel), goldenrod, sweet clover, *Phacelia* spp., sweet alyssum, buckwheat, amaranth, buckthorn, *Heteromeles arbutifolia.*
Tiger beetle (Cicindelidae family)	Maintain permanent plantings and some exposed dirt or sand areas.
Chalcid wasps (many families, including Trichogrammatidae)	Maintain a diversity of plants, including dill, anise, caraway, hairy vetch, spearmint, Queen Anne's lace, buckwheat, common knotweed, yarrow, white clover, tansy, cowpea, fennel, cosmos, chervil. For orchards, provide a mix of clover and flowering weeds.

COLLOPS BEETLE

Collops spp.

A: 4-7 mm long 

Plants Benefited: Vegetable

Prey: aphids, lepidopteran eggs and caterpillars, small Lygus nymphs, mites, whiteflies

Appearance: Collops adults are soft-winged beetles with bluish-black bodies and orange or red patches or stripes. Eggs are yellow to pinkish-orange and spindle-shaped. Most eggs are laid in clusters on soil debris and sometimes laid in the plant terminal. Larvae are pink to brownish-red and feed on insects in the soil.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter as adults.
- Generally, one generation per year.

When and Where to Scout:

- Adults may be found feeding on pollen at flowers.
- Collops are common in fields but are infrequent in vegetables.
- Larvae are seldom seen and occur mostly in ground litter.

Value: Collops beetles can be important early to mid-season predators to help suppress the development of economic populations of a wide array of insects.

Top Ways to Attract/Conserve:

- Provide nectar and pollen resources.
- Sensitive to neonicotinoids and broad spectrum insecticides.

Look-alikes: cereal leaf beetle, asparagus beetle

Collops beetle adult male.
Jessica Louque, Smithers Viscient, Bugwood.org

Collops beetle adult male.
Whitney Cranshaw, Colorado State University, Bugwood.org

Collops beetle adult.
Whitney Cranshaw, Colorado State University, Bugwood.org

Collops beetle adult.
Whitney Cranshaw, Colorado State University, Bugwood.org

Collops beetle adult.
Whitney Cranshaw, Colorado State University, Bugwood.org

Two-lined collops beetle (Collops vittatus).
Kansas Department of Agriculture , Bugwood.org

GROUND BEETLE

Approximately 2,500 species in the family Carabidae A: 3.2-12.7 mm long

Plants Benefited: Vegetable and Ornamentals

Prey: wide variety, including aphids, beetles, caterpillars, and grasshoppers, both above- and below-ground

Appearance: Adults are light to dark in color, with round head, hooked jaws, long legs, thread-like antennae, and an extended-oval abdomen. They range in size from 1 mm to 2.5 inches. Larvae are long and slender with dark coloration and pincher-like mandibles.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:

- Egg | Larva (3 stages) | Pupa | Adult
- Overwinter as adults or larvae within grass clumps. Females lay single or clusters of eggs in soil cracks and crevices. Larvae develop in the soil for 1 to 2 years. Adults may live an additional 1 or more years.
- One generation per year.

When and Where to Scout:

- Adults of most species feed nocturnally, so they are rarely seen.
- All season long, beetles may be found under debris, logs, in soil cracks, or moving along the ground.

Value: Highly valuable, as larvae and adults eat their body weight in prey each day, and larvae (in the soil) often kill more prey than they can eat.

Top Ways to Attract/Conserve:

- Create one or more permanent beetle banks (a long raised strip of bunch grasses) within the farm for shelter and overwintering habitat.
- Mulch areas of the farm for daytime habitat, and use compost or manure rather than fertilizer.
- Avoid excessive tilling and do not burn crop residue.

Look-alikes: other ground beetles, tiger beetles

Blue-margined ground beetle (Pasimachus elongatus). Whitney Cranshaw, Colorado State University, Bugwood.org

Boat-backed ground beetle (Scaphinotus viduus).
PA Department of Conservation and Natural Resources, Forestry, Bugwood.org

Caterpillar hunter ground beetle (Calosoma wilcoxi).
PA Department of Conservation and Natural Resources - Forestry , Bugwood.org

Fierce ground beetle (Pasimachus depressus).
Whitney Cranshaw, Colorado State University, Bugwood.org

Ground beetle adult.
Joseph Berger, Bugwood.org

Ground beetle larva.
Joseph Berger, Bugwood.org

LADY BEETLE (LADYBIRD BEETLE, LADYBUG)

Over 400 species in North America

A: 4-7 mm long
L: 1-9.5 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: aphids (primary), leafhopper, mites, scale insects, thrips, and whiteflies

Appearance: Adults are ¼ inch in length with convex bodies, ranging from cream to red to black in color, with or without black or red spots. Eggs are yellow to orange in color. Larvae are between ¼ and 3/8 inch in length, and blue-black to gray with yellow, red, or orange markings.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:

- Egg | Larva (3 stages) | Pupa | Adult
- Overwinter as adults in protected sites outdoors or in buildings. They emerge in early spring, seeking out prey. Females lay up to 500 eggs in clusters of 10-50, typically on the undersides of leaves. Larvae feed on prey for 4 to 6 weeks, and pupate where they feed.
- 2 to 3 generations.

When and Where to Scout:

- Use a beating tray to estimate populations of adult lady beetles. Look for clusters of yellow eggs on the bark and undersides of leaves on trees infested with their common prey (aphids).

Value: Highly valuable, as they are active from spring to fall. In its lifetime, a single lady beetle can consume up to 5,000 aphids.

Top Ways to Attract/Conserve:

- Large populations of aphids are the best attractant of lady beetles.
- Maintain insectary strips of continuous flowers as alternate food source (pollen, nectar) for adults.
- Bunch grasses or woody areas provide cool, humid habitat for hot, summer months.

Look-alikes: Colorado potato beetle

Seven spotted lady beetle (Coccinella septempunctata) is a non-native from Europe.

Thirteen-spotted lady beetle (Hippodamia tredecimpunctata) is associated with wet habitats.

Convergent lady beetle (Hippodamia convergens).

Twice stabbed lady beetle (Chilocorus stigma) is U.S. native, feeding on scale and aphid insects.

The convergent lady beetle is collected from the wild and sold commercially.

The multi-colored Asian lady beetle (Harmonia axyridis) is a common, non-native species that is out-competing our native lady beetles. They are identified by the prominent black 'M'-shaped marking behind its head.

LADY BEETLE (LADYBIRD BEETLE, LADYBUG) cont.

Over 400 species in North America

A: 4-7 mm long
L: 1-9.5 mm long

Transverse lady beetle (Coccinella transversoguttata) populations have been affected by non-native lady beetles.

The spider mite destroyer (Stethorus punctillum) is a tiny lady-beetle relative that targets the two-spotted spider mite and other small mites.

Western psyllobora (Psyllobora borealis) feeds on fungi, including fungi that cause powdery mildew.

Lady beetle eggs laid within an aphid colony.

When lady beetle larvae hatch, they first feed on their egg shells before moving on to prey.

Markings of lady beetle larvae are unique to their species. This is the multi-colored Asian lady beetle.

Larva of the convergent lady beetle.

Larva of the western psyllobora.

Lady beetles pupae (middle and right) and empty pupal case (left).

Lady beetle pupa.

ROVE BEETLE

Hundreds of species in the family Staphylinidae

A: most are 1-8 mm long 

Plants Benefited: Vegetable and Ornamental

Prey: soil pests such as soil stages of thrips, fungus gnats, slugs, snails, and springtails

Appearance: Adults are easily recognized by their square head, slender brown to black bodies (3-15 mm long), shortened wings, an abdomen that curls upward when disturbed (similar to scorpions). Larvae are thin, and pale yellow to dark brown.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:

- Egg | Larva (3 stages) | Pupa | Adult
- Overwinter in ground vegetation as larvae or adults. Adults lay eggs under leaves or amongst ground debris. Individual beetles live for up to 60 days.
- 1 or more generations per year.

When and Where to Scout:

- Rove beetles hide in soil or debris, and disperse quickly, so they are not usually seen. If encountered, they are easily recognized by their curving abdomen.
- Adults and larvae are effective soil-dwelling predators of mites and other small insects.

Value: Although rarely seen, rove beetles are moderately valuable. Adults can consume up to 150 fungus gnat larvae per day.

Top Ways to Attract/Conserve:

- Create a permanent beetle bank (a long raised strip of bunch grasses) within the farm for overwintering habitat.
- Well-established wildflower field borders sustain a diverse and abundant population of rove beetles.
- Limit tillage to protect larval and adult soil habitat.

Look-alikes: small ground beetles

Rove beetle adult.
Joseph Berger, Bugwood.org

Rove beetles.
David Cappaert, Bugwood.org

Rove beetle (Ontholestes cingulatus); note the distinctive yellow tail end. Jon Yuschock, Bugwood.org

Rove beetles resemble a scorpion when disturbed.
Sesil Corp

Rove beetle larva.
Fiveprime.org

Rove beetle (Nudobius luridipennis).
Gerald J. Lenhard, Louisiana State University, Bugwood.org

SOLDIER BEETLE

Family: Cantharidae

A: 1-15 mm long
L: 6-19 mm long

Plants Benefited: Vegetable and Ornamental

Prey: aphids, snails, slugs, insect eggs, mealybugs, caterpillars, root maggot larvae, and other soft-bodied insects

Appearance: Adults are elongate beetles with leathery wing covers and yellow, orange, or red bodies with black markings. Eggs are laid in clusters in moist soil or leaf litter. Larvae are velvety, covered with dense bristles, and have antenna-like projections on their head, though they are rarely observed because they develop in the soil.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter as larvae in leaf litter and loose soil. Larvae pupate in early summer and adults start emerging in late July. They lay eggs at the end of summer which soon hatch into larvae for overwintering.
- 1-2 generations per year.

When and Where to Scout:

- Adults are most commonly observed on yellow flowers late in the season, feeding on pollen and often coupled during mating.

Value: Soldier beetle larvae are the major predators. While adults primarily feed on nectar and pollen, they may feed on small insects such as aphids. Larvae contribute to natural control of a variety of insects.

Top Ways to Attract/Conserve:

- Provide and protect nectar and pollen resources.
- Protect egg-laying and larval habitat sites by avoiding soil fumigants and insecticides and reducing tillage.

Look-alikes: fireflies (minus the light-producing abdomen), wasps (when in flight), bees (when flying between flowers)

Soldier beetle adult.

Soldier beetle adult.
Jim Baker, North Carolina State University, Bugwood.org

Goldenrod soldier beetle (Chauliognathus pensylvanicus). Judy Gallagher, Wikimedia commons

Cantharis sp. soldier beetle.
Gail Hampshire, Wikimedia Commons

Soldier beetle adult.
gailhampshire, Wikimedia commons

Colorado plains soldier beetle (Chauliognathus basalis). Whitney Cranshaw, Colorado State University, Bugwood.org

TIGER BEETLE

Approximately 100 species (including *Cicindela* spp. and *Megacephala* spp.) in the family Carabidae

A: 15-40 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: wide variety of insects and arachnids such as ants, beetles, caterpillars, flies, and grasshopper nymphs

Appearance: Adults are one of the fastest-running insects, and prefer to hunt on open ground. They have long, thin legs, sickle-shaped jaws, heads wider than thorax, and bodies that range from gray-brown to iridescent greens and blues. Larvae are tan to pale brown with a large head and prominent hump with two pairs of hooks on their backs.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:

- Egg | Larva (3 stages) | Pupa | Adult
- Overwinter as adults in protected soil burrows and emerge ready to lay eggs starting in early to mid-spring. Females inserts single eggs in the soil, and each developing larva uses its mandibles to loosen the surrounding dirt of the burrow, pushing it to the surface.
- The larva remains anchored to the burrow wall over its 1 to 3-year lifetime, with its mandibles poised at soil level, ready to feed on any insect within reach. When mature, the larva pupates within the burrow. Adults may live up to 4 years.
- Multiple generations per year.

When and Where to Scout:

- Circular larval burrows may be seen on open ground at any time of the season.
- Adults are active during the day, and may be seen hunting on open ground. Species with colorful jewel tones are easiest to spot.

Value: Tiger beetles are important predators in nature, but most species are adapted to certain soil habitats and characteristics, so they may not occur frequently in cultivated systems.

Top Ways to Attract/Conserve:

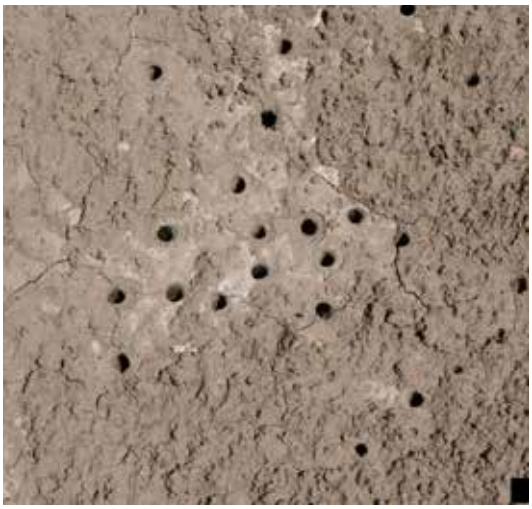
- Create one or more permanent beetle banks (a long, raised strip of bunch grasses) and exposed areas of soil within the farm for overwintering habitat.
- Mulch areas of the farm for daytime habitat, and use compost or manure rather than fertilizer.
- Avoid excessive tilling and do not burn crop residue.

Look-alikes: ground beetles

Tiger beetle adult.

Tiger beetle adult (Cicindela circumpicta).
Whitney Cranshaw, Colorado State University, Bugwood.org

Sidewalk tiger beetle (Cicindela punctulata) adult.
Whitney Cranshaw, Colorado State University, Bugwood.org



Sidewalk tiger beetle larval tunnel openings.
Whitney Cranshaw, Colorado State University, Bugwood.org

Sidewalk tiger beetle larva.
Whitney Cranshaw, Colorado State University, Bugwood.org

Six-spotted tiger beetle (Cicindela sexguttata).
David Cappaert, Bugwood.org

APHID PREDATORY MIDGE

Aphidoletes spp. L-A: 2-3 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: aphids

Appearance: Adults are a tiny fly that resembles mosquitoes, with extended antennae and long, drooping legs. Larvae (maggots) are orange and though they are smaller than aphids. Their strong mouthparts are able to hold their paralyzed prey upward as the contents are consumed.

Predacious Lifestage(s):
Larva (adults feed on nectar and honeydew)

Life Cycle:
- Egg | Larva | Pupa | Adult
- Overwinter as larvae in the soil, and pupate and emerge as adults in late spring. The females seek out aphids by detecting the honeydew scent, and lay around 70 tiny, orange eggs within the colonies.
- Three to six generations per year .

When and Where to Scout:
- Midges fly at night, so they are rarely seen.
- Starting in late spring, look for orange, maggot-like larvae among aphid colonies on the undersides of leaves.
- Shriveled, dead aphids remain attached to leaves and are brown to black.

Value: This is a highly beneficial insect, but not commonly found. A single larva consumes 7 to 80 aphids in its lifetime.

Top Ways to Attract/Conserve:
- Midges are more active in high humidity.
- Provide a season-long source of nectar from tiny flowers (see pages 7-9 for a list of plants).
- Maintain small populations of aphids to promote buildup of midge population.

Look-alikes: gnats and other midges, mosquitoes, syrphid fly larva

Aphid midge adult.
www.pirlot.pro

Aphid predatory midge (Aphidoletes aphidimyza) larva in aphid colony.
Whitney Cranshaw, Colorado State University, Bugwood.org

Aphid predatory midge (Aphidoletes aphidimyza).
Koppert Biological Systems

Aphid midge larvae.
Ivia.es

Aphidioletes midge larva in aphid colony.
Whitney Cranshaw, Colorado State University, Bugwood.org

Aphidioletes midge larva with aphids.
Whitney Cranshaw, Colorado State University, Bugwood.org

LONG-LEGGED FLY

Many species in the family Dolichopodidae

A: 1-9 mm long 

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: Soft-bodied arthropods such as springtails, aphids, gnats, midges, other flies, thrips, and insect eggs. Long-legged fly larvae in the *Medetera* genus attack bark beetle larvae.

Appearance: Adults are small flies with long legs and are often found resting on plant leaves in the garden. Many are metallic green, blue, or copper in color. Larvae are translucent, white, smooth-bodied maggots, and can be found in moist soil or under bark. Pupae make cocoons made of soil particles.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- Life cycle is not well-understood, but most likely, they overwinter as pupae in the soil and adults emerge in mid- to late spring. Mating occurs after elaborate male displays.
- Multiple generations per year.

When and Where to Scout:

- Look for adult flies resting on shaded plant leaves throughout the growing season.
- Larvae are rarely seen.

Value: Adults are commonly found, but their value in pest reduction is unknown in Utah.

Top Ways to Attract/Conserve:

- Adults prefer shady, moist, locations such as woodland and meadows.
- Adults will also feed on nectar.

Look-alikes: small beneficial wasps

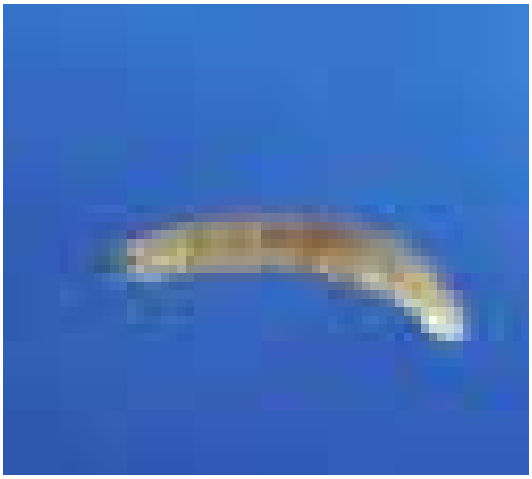
Long-legged fly adult.
Creative commons

Green long-legged fly.
Bernard DUPONT from FRANCE, Wikimedia Commons

Long-legged fly adult.

Long-legged fly adult.

Long-legged fly adult.
Joseph Berger, Bugwood.org



Long-legged fly larva.
Gerald J. Lenhard, Louisiana State University, Bugwood.org

ROBBER FLY

Family: Asilidae A: 3-50 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: bees, dragonflies, grasshoppers, wasps, other flies, some spiders, and several other insects (both pests and beneficials)

Appearance: Adult flies have a characteristic "beard" of hairs surrounding their mouthparts. Some species have dense bristles covering their bodies while others are nearly hairless. Eggs are whitish in color and laid on low-lying plants and grasses, or in protected areas such as soil crevices, bark, or wood. Larvae live in the soil or decaying organic matter and are light in color with a segmented body and dark mouthparts. Pupae migrate to the soil surface and emerge as adults.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:
- Egg | Larva | Pupa | Adult
- Overwinter as larvae in the soil, and emerge as adults as the weather warms up. Their entire life cycle takes at least a year.
- One generation per year.

When and Where to Scout:
- Robber flies can be seen perching (generally in open, sunny locations) in order to locate their prey.
- They tend to congregate near forest edges, or in grasslands.

Value: Robber flies are voracious predators feeding on flying pests as well as beneficial insects and spiders. Overall they are considered helpful as a biological control in gardens.

Top Ways to Attract/Conserve:
- They are not known to feed on pollen or nectar, but adults will sit on flowers waiting for prey.

Look-alikes: wasps, bees

Adult robber fly.
Jim Baker, North Carolina State University, Bugwood.org

Adult robber fly.
Edward L. Manigault, Clemson University Donated Collection, Bugwood.org

Robber fly eating a bee.
Jessica Louque, Smithers Viscient, Bugwood.org

Robber fly with prey.
Jon Yuschock, Bugwood.org

Robber fly adult.
David Cappaert, Bugwood.org

Robber fly nest.
Jessica-Louque,-Smithers-Viscient,-Bugwood.org

SYRPHID FLY (HOVER FLY)

Several hundred species in the family Syrphidae

A: 4-24 mm long
L: 1-13 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: aphids, leafhopper, pear psylla, scale insects, spider mites, thrips, and other soft-bodied insects

Appearance: Adults have a hovering flight pattern, and resemble bees with black and yellow striped abdomen, but have flatter bodies and only one set of wings. Larvae are 10-15 mm maggots with a yellow to olive color, tapered body towards the head, and with or without a white stripe down the side. Eggs resemble minuscule grains of rice and are laid singly on leaves that harbor aphid colonies.

Predacious Lifestage(s):
Larva

Life Cycle:

- Egg | Larva (3 stages) | Pupa | Adult
- Overwinter as larvae or adults in protected areas. In spring, adults require pollen and seek out flowers to feed before they can start laying eggs. They find aphids via volatile scents released both by the plants and by the aphids' honeydew, and lay eggs among them. When mature, larvae drop to the ground to pupate. Generally, the life cycle is 2 to 4 weeks.
- 3 or more generations per year.

When and Where to Scout:

- Adults can be seen moving quickly from flower to flower. Although they resemble small bees or wasps, their hovering flight pattern is distinctive.
- Starting in mid-spring and throughout the season, search within aphid or thrips colonies to locate the rice-like syrphid eggs or slug-like larvae.
- Another indication of syrphid flies are black, oily smears (excrement) among prey.

Value: Highly important predator, but often under appreciated because larvae tend to seek shelter during the day, and feed at night. Larvae can consume up to 400 soft-bodied insects in their lifetimes.

Top Ways to Attract/Conserve:

- Syrphid fly adults require pollen and nectar in order to reproduce, so providing a summer-long source of flowers is important. One or more strip of plants with small flowers (alyssum, dill, fennel, mint, etc.) between tree or vegetable rows is highly beneficial.
- Limit tilling and burning to protect overwintering habitat.
- Because the larvae require populations of aphids or other soft bodied insects for sustenance, they are in direct competition with lady beetles. This competition may lead to one or the other being dominant on the farm.

Look-alikes: larvae resemble other beneficial maggots such as the aphid predatory midge; adults resemble bees

Syrphid fly adults are not predatory, and require pollen and nectar to survive.

Syrphid fly larvae are voracious predators of aphids.

Syrphid fly adult.
David Susan Ellis, Bugwood.org

Syrphid fly larva eating woolly apple aphids.

Syrphid fly eggs are laid among their prey, and resemble a grain of rice.

Syrphid fly larva eating an aphid.
David Cappaert, Bugwood.org

LACEWINGS (aphid lion)

Several species in the families
Neruoptera (green lacewing)
and Hemerobiidae (brown lacewings)

A: 2-25 mm long
L: 1-10 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: aphids (primary), leafhoppers, scale, spider mites, thrips, and others

Appearance: Adults are 15 to 20 mm in length with green or brown coloration and large, lace-like wings that fold along the sides of its body. Eggs are oval white spheres suspended on a stalk about 6 mm in length. Larvae are alligator-shaped with yellow to gray mottled coloration and sickle-like mandibles which extend past the head.

Predacious Lifestage(s):
Larva (in some species, adult)

Life Cycle:

- Egg | Larva (3 stages) | Pupa | Adult
- Overwinter as pupae or adults in leaf litter and other protected areas. Adults emerge early in spring to seek out nectar. Females lay more than 200 eggs within their prey (either singly or in clusters), and larvae feed for 1-3 weeks before pupating on leaves or in sheltered areas.
- 1 to 3 generations per year.

When and Where to Scout:

- Beating trays are effective tools to monitor lacewing adults and larvae. It is best to sample early in the day while it is still cool.
- When monitoring aphid colonies, also look for lacewing larvae.
- Adults are active at night, found on flowers or at prey sources.

Value: Lacewings are highly important due to their abundance, voracious appetite, and early spring activity. Larvae are nicknamed "aphid lion," and can consume more than 200 aphids per week.

Top Ways to Attract/Conserve:

- Maintain an unsprayed edge habitat for overwintering and alternate prey.
- Provide insectary strips within and around the farm to provide nectar and pollen-producing plants for adults.
- Maintain small populations of aphids around the farm to build populations of lacewings and provide honeydew for adults.

Look-alikes: Adults are unique in appearance; larvae resemble damsel bug larvae

Brown lacewing adult.

Green lacewing adult.

Lacewing eggs are laid on a silky stalk to protect them from predators.

Lacewing pupae.

Lacewing larva.

Lacewing larva feeding on an aphid.
Bradley Higbee, Paramount Farming, Bugwood.org

DUSTYWINGS

Family: Coniopterygidae

A: 1-4 mm long
L: 1-3.5 mm long

Plants Benefited: Fruits and Ornamentals

Prey: insect eggs, aphids, scale insects, mites, whiteflies, and other small soft-bodied arthropods

Appearance: Adults have long antennae, prominent eyes, a whitish powdery coating on their wings which are held like a tent over the abdomen when at rest. Eggs are oblong and laid on foliage or bark near pest infestations. Larvae are gray, white, and black with a tapered body. Pupae are inconspicuous with a flat, white, silken cocoon and often found on the underside of leaves.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter as larvae.
- 2 generations per year.

When and Where to Scout:

- Dustywings are easily overlooked because they are small.
- Adults are most often found on trees and shrubs and are active at dawn and dusk.
- To differentiate between look-alikes, watch for wings that are held like a tent over the abdomen when at rest.

Value: Although easily overlooked, dustywings can be economically important predators of their prey.

Top Ways to Attract/Conserve:

- Maintain an unsprayed edge habitat for overwintering and alternate prey.
- Provide insectary strips within and around the farm to provide nectar and pollen-producing plants for adults.

Look-alikes: small moths, whiteflies

Dustywing adult found under an English holly leaf.
Cheryl Moorehead, Bugwood.org

Dustywing adult found under an English holly leaf.
Cheryl Moorehead, Bugwood.org

Dustywing adult.
Bj.schoenmakers Wikimedia Commons

Dustywing larva.
Brenda Dobbs

Dustywing larva.
Rayanne Lehman, Pennsylvania Department of Agriculture, Bugwood.org

Dustywing larva.
Cheryl Moorehead

RED VELVET MITE

Family: Trombidiidae

A: 4-12 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: attach to, and feed on, bodies of larger arthropods such as beetles, butterflies/moths, and grasshoppers; also feed on insect eggs and smaller, soft-bodied insects such as aphids, spider mites, leafhoppers, and thrips

Appearance: Adults are a bright red mite with a velvety texture and a tick-like shape. The red velvet mite is larger than other mites and moves very quickly along plant surfaces.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:

- Egg | Pre-larva | Larva | Protonymph | Deutonymph | Tritonymph | Adult
- Overwinter as adults in the soil.
- Eggs are laid in the soil in the spring.
- Generally, one generation per year.

When and Where to Scout:

- Parasitic red velvet mite larvae are found on arthropod hosts.
- While the active deutonymph and adult stages are most often found on the soil, they have also been found in the canopy of plants.
- Some species emerge from the soil after a spring or fall rainstorm.

Value: Red velvet mites are an important part of the soil and leaf litter ecosystem, helping to increase decomposition in the soil layer by feeding on other mites and small arthropods that interfere with the decomposition process. Velvet mites have also been used to control populations of certain locusts. Thousands of species occur.

Top Ways to Attract/Conserve:

- A healthy soil, high in organic matter, provides the best environment for red velvet mites.
- Research indicates flood irrigation discourages establishment of red velvet mite populations.
- Sensitive to broad-spectrum insecticides and miticides.

Look-alikes: red spider mites, clover mites

Red velvet mite.

Red velvet mite attached to a harvestman.
mobugs.blogspot.com

Red velvet mite.
Tom Chester

Red velvet mite.
Tom Chester

Red velvet mite.
Judy Gallagher

Red velvet mite.
Thomas Shahan

SPIDER MITE DESTROYER

Stethorus spp.

A: 1.5 mm long
L: 2 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: two-spotted spider mite

Appearance: Adults are tiny (1-2 mm), oval-shaped, black lady beetles, about 1 mm in length, with silvery hairs on their body. Eggs are miniscule, gray, and spindle shaped, found within mite colonies. Larvae are dark brown to black with small spines, and slow-moving.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:

- Egg | Larva (3 stages) | Pupa | Adult
- Overwinter as adults in dead leaves and other debris, emerging in mid-spring. By mid-summer, females lay up to 1,000 eggs among spider mite colonies, and live up to 2 years. Larvae feed on mites for up to two weeks before pupating.
- One generation per year.

When and Where to Scout:

- Use beating trays (shaking a limb or vegetable plant over a cloth tray to dislodge insects) starting in late spring to determine whether *Stethorus* are present.
- Use a 10x hand lens to spot the shiny black beetles or velvety-gray larvae amongst spider or rust mite colonies on the undersides of leaves.

Value: Somewhat valuable, but alone, cannot keep mite populations in check. Females must eat 20-40 spider mites per day to initiate and sustain egg laying, while larvae can consume up to 250 mites in this stage.

Top Ways to Attract/Conserve:

- In orchards, early spring pest mites such as rust and blister mites, are important food sources before spider mites enter the trees.
- Do not use miticides in early spring so that *Stethorus* populations can increase.

Look-alikes: flea beetles

Spider mite destroyer adult.

Spider mite destroyer adult.
Whitney Cranshaw, Colorado State University, Bugwood.org

Spider mite destroyer feeding on spider mites.
Department of Agriculture & Food, Western Australia, Bugwood.org

Spider mite destroyer larva.
Department of Agriculture & Food, Western Australia, Bugwood.org

Spider mite destroyer adults, top and bottom sides.

Sider mite destroyer pupa.
Whitney Cranshaw, Colorado State University, Bugwood.org

WESTERN PREDATORY MITE

Galendromus occidentalis A: 0.5 mm long

Plants Benefited: Fruit (primarily), Vegetable, and Ornamental

Prey: blister mites, rust mites, two-spotted spider mites, and other mite species (not eggs)

Appearance: One of the primary native spider mite predators in the western U.S., tolerating hot, dry conditions. Adults are shiny, pear-shaped with the taper at the head, and range in color from red, yellow to beige. Must use a 10x hand lens to see.

Predacious Lifestage(s):
Nymphs (stages 2 and 3), Adult

Life Cycle:

- Egg | Immatures (3 stages) | Adult
- Overwinter as mated adult females in fruit trees or groundcovers, emerging in early spring. Depending on the prey available, they will disperse to different areas of the farm. Females lay around 21 pear-shaped eggs over the course of their 30-day life span.
- 8 to 10 generations per year.

When and Where to Scout:

- Look for predatory mites season-long on the undersides of leaves and within spider mite colonies.
- Predatory mites will be shinier, pear-shaped, and faster-moving.
- At least 2 predatory mites per leaf will help to keep pest mites in check.

Value: Western predatory mites are extremely important in keeping pest mites in check. Adults eat 1-3 pest mites or up to 6 pest eggs per day over their 5-week lifespan.

Top Ways to Attract/Conserve:

- Allow some pest mites such as rust or blister mites to survive to provide early-season food sources.
- Provide flowering plants, as adults may also feed on pollen when prey is scarce.
- Maintain cover crops or ground covers for habitat and alternate prey.
- Highly sensitive to insecticides and miticides.

Look-alikes: other species of predatory mites

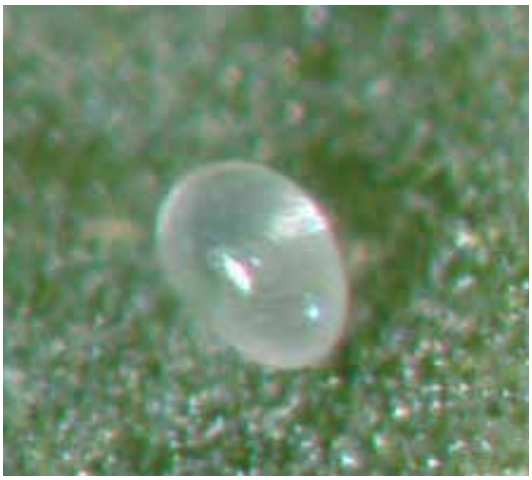
Western predatory mite attacking a European red mite. Elizabeth H. Beers

Western predatory mite attacking a pest mite.
International Institute of Tropical Agriculture

Western predatory eating a spider mite.
Ricky Lara Center for Invasive Species

Western predatory eating a spider mite.

Western predatory mites are pear shaped.



Western predatory mite egg.
Elizabeth H. Beers

SPIDERS

More than 600 species found in agricultural crops such as:

Crab spiders (Thomisidae family).....A: 2-11 mm long
Jumping spiders (Salticidae family).....A: 1-22 mm long
Wolf spiders (Lycosidae family).....A: 3-35 mm long
Woodlouse spiders (Dysderidae family) .....A: 9-15 mm long
Orb-web spiders (Araneidae) .....A: 2-30 mm long
Funnel-web spiders (Agelenidae family).....A: 5-18 mm long
Daddy longlegs (Opiliones order;
Leiobonum spp, *Phalangium opilio*).....A: 2-12 mm long

Plants Benefited: a wide variety of arthropods

Prey: a wide variety of arthropods

Appearance: Spiders have 4 pairs of legs. Important groups of pest-eating spiders include wolf spiders, orb weavers, jumping spiders, and sheet-weaving spiders. Wolf spiders chase down their prey at ground level or on plants. Orb weavers can create large vertical webs suspended between plants and they catch more prey than they can consume. Jumping spiders lie in wait within plants and pounce on their prey. Sheet weavers can travel long distances between fields.

Predacious Lifestage(s):
Spiderlings, Adults

Life Cycle:

- Egg | Spiderling (multiple stages) | Adult
- Overwinter in protected areas as adults or egg masses in silken nests. Emergence is early spring before many other beneficials. Life cycle from egg to adult can take 1 year, while some adults may live for up to 3 years.
- One generation per year.

Value: Spiders are highly important in natural biocontrol. A research study found that total worldwide consumption by spiders is 400 to 800 million tons of arthropods per year.

Top Ways to Attract/Conserve:

- Maintain undisturbed natural areas containing a mix of woody plants and flowers around or within the farm. These areas will sustain spider populations that will then move into the crops.
- Cover crops, stubble residue, and mulches can also support spider activity.
- Avoid tillage.

Look-alikes: none

Crab spider.
David Cappaert, Bugwood.org

Jumping spider.
David Cappaert, Bugwood.org

Wolf spider.
David Cappaert, Bugwood.org

Woodlouse spider.
Joseph Berger, Bugwood.org

Orb-weaver spider.
David Cappaert, Bugwood.org

Funnel-web spider.
Joseph Berger, Bugwood.org

BANDED THRIPS (BANDED WING THRIPS)

Family: Aeolothripidae
Aeolothrips spp.

A: 1.5 mm long
L: 0.5-1.5mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: aphids, mites, thrips, whiteflies

Appearance: Adults are fairly large thrips with black bodies and white banding across the forewings. Larvae are yellowish, shading into orange at the posterior end.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:

- Egg | Larva (2 stages) | Pre-pupa | Pupa | Adult
- Overwinter as adults, sheltered in trees or groundcover and emerging in late spring. Females lay eggs embedded within the leaf tissue near colonies of spider mites. Larvae feed on mites over a period of 10 days and then pupate in the soil. Adults live approximately 30 days.
- Multiple generations per year.

When and Where to Scout:

- When scouting for spider mites and pest thrips in early summer, use a hand lends to look for banded thrips adults. They may also be detected by shaking branches or plants over a cloth tray.

Value: Value is moderate. Banded thrips have potential to control onion thrips, especially in July and August when both species occur in high numbers.

Top Ways to Attract/Conserve:

- Learn to identify adult pest thrips from beneficial thrips so that insecticides are not used unnecessarily.
- Cover crops such as vetch or mustard can be attractive to beneficial thrips.

Look-alikes: other pest and beneficial thrips, minute pirate bug

Banded thrips adult.
Peter J. Bryant

Banded thrips adult, showing feathery wings.
Patrick Marquez, USDA APHIS PPQ, Bugwood.org

Banded thrips adult.

Banded thrips adult on beating tray fabric.

Banded thrips adult on a corn leaf.

Vespiform thrips (Franklinothrips vespiformis).
Whitney Cranshaw, Colorado State University, Bugwood.org

BLACK HUNTER THRIPS

Leptothrips mali A: 1.6 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: aphids, leafhoppers, moth eggs, thrips, spider mites, and more

Appearance: Thrips have tiny, long, thin, pointed bodies; adults and young are dark red to brown to black. They are highly active, with a solitary predatory behavior.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:

- Egg | Larva (2 stages) | Pre-pupa | Pupa | Adult
- Overwinter as adults, sheltered in trees or groundcover. They emerge in early spring to seek out prey. Populations are slow to build since females only lay 1 to 2 eggs each. Pupation occurs in the soil.
- 1 to 2 generations per year.

When and Where to Scout:

- These predatory thrips are more commonly found in fruit trees, but can move to vegetable fields.
- Starting in late spring, shake branches over a cloth tray. Look at the dislodged insects on the cloth. The black hunter thrips are slim-bodied, fast-moving, and appear entirely black.

Value: Moderately valuable because populations are slow to build. They can reduce high mite populations, but usually occur too late to prevent damage by themselves.

Top Ways to Attract/Conserve:

- Learn to identify pest thrips from beneficial thrips so that insecticides are not used unnecessarily.
- Cover crops such as vetch or mustard can attract populations.

Look-alikes: western flower thrips (pest); banded thrips (beneficial)

Black hunter thrips adult.
Mid-Atlantic Orchard Monitoring Guide

Black hunter thrips nymph.
Mid-Atlantic Orchard Monitoring Guide

Black hunter thrips adult.
Ilona L., Bugguide.net

Black hunter thrips adult.
Stalk of Fennel

Black hunter thrips.

Black hunter thrips.

SIX-SPOTTED THRIPS

Scolothrips sexmaculatus A: 0.8 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: spider mites

Appearance: Adults are tiny, with slender, pale-yellow bodies and three dark spots on each wing cover and long fringes on the wing margins. Larvae resemble other thrips species in that they are creamy-white to yellow, and worm-like.

Predacious Lifestage(s):
Larva, Adult

Life Cycle:

- Egg | Larva (2 stages) | Pre-pupa | Pupa | Adult
- Overwinter as adults, sheltered in trees or groundcover and emerging in late spring. Females lay eggs embedded within the leaf tissue near colonies of spider mites. Larvae feed on mites over a period of 10 days and then pupate in the soil. Adults live approximately 30 days.
- Multiple generations per year.

When and Where to Scout:

- When scouting for spider mites in early summer, use a hand lends to look for six-spotted thrips adults on the undersides of leaves. They may also be detected by shaking branches or plants over a cloth tray.
- Larval six-spotted thrips look identical to pest thrips, but you may find them feeding on mites.

Value: Value is moderate, but their populations are spotty in Utah. Although larvae eat 10 mite eggs per day while adults eat about 60, six-spotted thrips don't increase their population size until after mites have become abundant and damaging.

Top Ways to Attract/Conserve:

- Learn to identify adult pest thrips from beneficial thrips so that insecticides are not used unnecessarily.
- Cover crops such as vetch or mustard can be attractive to beneficial thrips.

Look-alikes: other pest and beneficial thrips

Six-spotted thrips adult.
UC Riverside

Six-spotted thrips adult.
Walter P. Pfiegler

Six-spotted thrips larva.
Jack Kelly Clark, University of California

Six-spotted thrips adult.
Jack Kelly Clark, University of California

Six-spotted thrips.
Lucidcentral.org

Six-spotted thrips adult.
The Almond Doctor

ASSASSIN BUG (AMBUSH BUG)

Approximately 100 species in the family Reduviidae (e.g. Ambush Bug: *Phymata* spp.)

A: 12-19 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: wide variety of soft-bodied insects such as aphids, caterpillars, thrips, and small plant bugs

Appearance: These insects lie in wait for their prey, and attack with force. Adults have flat, green to brown bodies, long narrow head, bristly legs that are specialized for hunting, and a dagger-like mouthpart that injects prey with a lethal toxin, killing it within seconds.

Predacious Lifestage(s):
Nymph, Adult

Life Cycle:

- Egg | Nymph (5 stages) | Adult
- Overwinter as nymphs or adults in protected areas or groundcover. After emerging in mid to late spring, females lay clusters or rows of barrel-shaped eggs on leaves or stems.
- Nymphs disperse and begin hunting for food. They can consume up to 160 small to medium-sized insects before reaching adult.
- Adults may live up to 10 months and lay up to 300 eggs.
- One generation per year.

When and Where to Scout:

- Assassin bugs may be noticed in late spring.
- They are elusive and rarely seen; shake plants over a sheet or tray to determine their presence.

Value: Although they are aggressive predators and will often kill more prey than they need to consume, they may also feed on other beneficials.

Top Ways to Attract/Conserve:

- Maintain diverse habitats from grasses to forbs to woody plants.
- Increase overwintering survival with cover crops.
- Assassin bugs are more tolerant of commonly used pesticides than other beneficials.

Look-alikes: leaf-footed plant bug, squash bug

Ambush bug adult on corn.

Ambush bug adult on a sunflower leaf.

Ambush bug nymph.
Jeff D. Hole

Adult ambush bug feeding on a green sweat bee.
Whitney Cranshaw, Colorado State University, Bugwood.org

Ambush bug adult.
David Cappaert, Bugwood.org

Ambush bug feeding on western corn rootworm.
Whitney Cranshaw, Colorado State University, Bugwood.org

BIG-EYED BUG

Geocoris spp. A: 3-5 mm long

Plants Benefited: Vegetable and Ornamental

Prey: aphids, caterpillars, flea beetles, leafhopper, psyllids, spider mites, thrips, whiteflies, and eggs and nymphs of plant bugs

Appearance: Adults have a broad head with widely separated bulging eyes, small stout body, and relatively thick antennae. They range in color from shiny black to grey or yellowish with red-brown spots. They attack prey with needle-like mouthparts that pierce and suck up body contents.

Predacious Lifestage(s):
Nymph, Adult

Life Cycle:
- Egg | Nymph (5 stages) | Adult
- Overwinter as adults in ground litter. Females lay up to 150 eggs on leaves or plant litter near prey source. Nymphs develop to adult in approximately 4 weeks.
- Multiple generations per year.

When and Where to Scout:
- Adults are first seen in spring when other insects such as lygus bugs begin to increase to economic levels.
- Cylindrical eggs are laid singly on dead leaves, stems, or within soil crevices during spring and summer.
- Adults and nymphs may be found in plant debris, at base of plant stems or in cracks at the soil surface from spring until the end of the season.

Value: Big-eyed bugs are more commonly found in field crops, but where they occur, they actively seek out prey. A single adult bug may consume 80 spider mites per day.

Top Ways to Attract/Conserve:
- Build up populations in cool-season cover crops such as clover.
- Provide permanent, un-tilled plantings of bunch grasses or small shrubby plants for overwintering habitat.
- Nectar and seeds can provide an alternate food source when prey is limited.

Look-alikes: lygus bug (pest), false chinch bug (pest), black grass bug (pest), minute pirate bug (beneficial)

Big-eyed bug nymph.

Big-eyed bug adult.
Bradley Higbee, Paramount Farming, Bugwood.org

Big-eyed bug adult.

Big-eyed bug adult feeding on an unidentified homopteran. Russ Ottens, University of Georgia, Bugwood.org

Big-eyed bug egg.
Jack Kelly Clark, UC Statewide IPM Project

Big-eyed bug nypmh.
Bradley Higbee, Paramount Farming, Bugwood.org

CAMPYLOMMA BUG

Campylomma verbasci

A: 2.5 mm long
N: 0.5-2.5 mm long

Plants Benefited: Fruit

Prey: aphids, leafhopper, pear psylla, spider mites, thrips, and other soft-bodied insects

Appearance: As nymphs, campylomma can cause blister-like damage to apple and pear fruits. Adults, however, are predacious on soft-bodied insects. They have oval, gray-brown bodies about 2.5 mm in length, black spikes on the legs, and a dark spot on the antennae. Nymphs resemble aphids but are fast-moving and lack the cornicles (tailpipes). They have a pale green color and dark spines on their legs.

Predacious Lifestage(s):
Nymph, Adult

Life Cycle:

- Egg | Immatures (3 stages) | Adult
- Overwinter as sac-shaped eggs in bark cracks and crevices. Eggs hatch during bloom. Nymph stage lasts approximately 21 days, where they may feed on the skin of developing fruitlets if smaller insects are not available. Females lay up to 40 eggs, and adults feed primarily on insects in trees and groundcover. In late August, adults return to their woody hosts to mate and produce eggs for overwintering.
- 2 to 4 generations per year.

When and Where to Scout:

- During bloom, use beating trays (or shake flowers into paper cups) to gather nymph samples and determine whether or not to control the species or keep it as a beneficial.
- Visual inspection may also be used to nymphs.
- By late May, adults will be present in beating tray samples.

Value: Damage to fruit must be weighed against the biological control benefit in order to determine if campylomma is being beneficial or economically destructive.

Top Ways to Attract/Conserve:

- Adults often migrate in mid-summer to mullein to feed on thrips.
- Campylomma are attracted to woody hosts such as pear and apple trees that have populations of thrips and aphids. There is a correlation between high aphid populations and subsequent campylomma residency.
- Very tolerant of insecticides.

Look-alikes: aphids and leafhopper (nymphs); lygus bug, big-eyed bug, and other mirids (adults)

Campylomma bugs are also called mullein plant bug. Adults are beneficial predators.
Bradley Higbee, Paramount Farming, Bugwood.org

Campylomma bug adult.
Tristan Bantock 2009

Campylomma bug adult.
Bj.schoenmakers, Wikimedia Commons

Campylomma bug nymphs can be a pest, causing blister-like damage to apple and pear fruits.

Campylomma bug nymphs.
Bradley Higbee, Paramount Farming, Bugwood.org

Campylomma bug nymph.

DAMSEL BUG

Nabis spp. plus 3 other genera in the family Nabidae

A: 8-12 mm long
N: 3-8 mm long

Plants Benefited: Vegetable and Ornamental

Prey: aphids, beetle larvae, leafhoppers, caterpillars and moth eggs, and other small insects

Appearance: Adults are tan-colored with long, thin bodies, slender head, and long antennae. Nymphs may resemble ants. This generalist predator actively seeks out prey, pierces it with needle-like mouthparts and sucks up the body contents.

Predacious Lifestage(s):
Nymph, Adult

Life Cycle:

- Egg | Nymph (5 stages) | Adult
- Overwinter as adults in protected areas of field crops or shrubby areas and become active in late spring. Females lay up to 200 eggs, and populations peak in mid to late summer.
- 1 to 5 generations per year.

When and Where to Scout:

- Damsel bugs appear later in the season than other predators; starting in mid-summer.
- They are elusive and rarely seen, and move rapidly when disturbed.

Value: Not a significant predator in fruit or vegetable production, but can be encouraged with grasses and groundcovers.

Top Ways to Attract/Conserve:

- Often associated with meadows, pasture, alfalfa and other field crops; farms with or near these areas will have more damsel bug activity.
- According to research, damsel bugs are more abundant in no-till systems.
- Intercrop vegetables with two or more crops rather than single-species plantings.

Look-alikes: assassin bug, leaf-footed plant bug, chinch bug

Common damsel bug (Nabis americoferus).
Joseph Berger, Bugwood.org

Common damsel bug nymph.
Phil Sloderbeck, Kansas State University, Bugwood.org

Damsel bugs may lie in wait at flowers for prey.

Damsel bug feeding on a winged aphid.

Damsel bug.

Damsel bug.

DERAEOCORIS BREVIS

Deraeocoris brevis A: 3-6 mm long

Plants Benefited: Fruit trees and other woody plants

Prey: aphids, leafhoppers, pear psylla (primarily), scale insects, and spider mites

Appearance: Adults are shiny black and 1/4 inch long. Nymphs are mottled cream and black with long, gray hairs and a cottony-looking secretion on the body.

Predacious Lifestage(s):
Nymph, Adult

Life Cycle:
- Egg | Nymph (5 stages) | Adult
- Overwinter as adults in protected areas in fruit trees or groundcover. Females start emerging in mid-spring. Each female inserts up to 240 eggs into tissue of petioles and leaf veins.
- 1 generation per year.

When and Where to Scout:
- This insect is elusive but can be detected by shaking branches over a cloth tray.
- Timing and peak abundance has not been determined in Utah.

Value: One of the most important predators of pear psylla; one nymph can eat as many as 400 pest eggs and nymphs.

Top Ways to Attract/Conserve:
- Maintain other unsprayed woody plant material near fruit trees to attract and promote Deraeocoris.
- Highly susceptible to many pesticides.

Look-alikes: nymphs are unique; adults resemble big-eyed bugs and lygus bugs

Deraeocoris brevis adult.
Paramount Farming, Bugwood.org

Deraeocoris brevis adult.
Creative Commons Share-Alike, Centre for Biodiversity Genomics

Deraeocoris brevis adult.
Creative Commons Share-Alike, Centre for Biodiversity Genomics

Deraeocoris brevis adult.
Creative Commons Share-Alike, Centre for Biodiversity Genomics

Deraeocoris brevis nymph.

Deraeocoris brevis nymph.
Bradley Higbee, Paramount Farming, Bugwood.org

MINUTE PIRATE BUG (FLOWER BUG)

Orius insidiosus

A: 3-6 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: aphids, insect eggs, spider mites, and thrips (primarily)

Appearance: Adults are tiny ("minute") and have a distinctive black and white pattern. Nymphs are yellow to orange and as they mature, the abdomen becomes amber-colored. Their small size (1.5 mm) requires a 10x hand lens to see.

Predacious Lifestage(s):
Nymph, Adult

Life Cycle:

- Egg | Nymph (5 stages) | Adult
- Overwinter as adults in bark crevices or leaf litter. They emerge in mid-spring, and females lay up to 130 eggs, embedded singly within leaf tissue. Nymphs feed on prey for 4 weeks.
- 2 to 4 generations per year.

When and Where to Scout:

- Beating trays are an effective means of monitoring for the presence of both nymphs and adults.
- Look for adults on flowers, including sunflower, buckwheat, and those in the carrot family.

Value: Highly important, especially against thrips and spider mites, as they reproduce very rapidly (15 days) and actively seek out prey. They can consume up to 30 small insects per day.

Top Ways to Attract/Conserve:

- Once established, minute pirate bugs often remain for years. They are somewhat tolerant to most insecticides but are very susceptible to pyrethroids.
- Maintain unsprayed plantings on the farm that include grasses and woody plant material for shelter, alternate food source, and overwintering habitat.
- Include insectary strips among the crops to provide pollen and nectar, which adults need to survive.

Look-alikes: big-eyed bug (beneficial), lygus bug (pest), false chinch bug (pest), black grass bug (pest)

Minute pirate bug nymph feeding on a thrips.

Minute pirate bug adult.
Phil Sloderbeck, Kansas State University, Bugwood.org

Minute pirate bug adult feeding on a thrips.

Minute pirate bug feeding on an aphid.
Paramount Farming, Bugwood.org

Minute pirate bug feeding on an aphid.
Paramount Farming, Bugwood.org

Minute pirate bug nymph feeding on a spider mite.

PREDATORY STINK BUGS

Rough Stink Bug (*Brochymena quadripustulata*, *B. pustula*) ..... A: 13-20 mm long
Spined Soldier Bug (*Podisus maculiventris*)..... A: 8.5-13 mm long
Twospotted Stink Bug (*Perillus bioculatus*)..... A: 8.5-11.5 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: beetle larvae (twospotted stink bug specializes in Colorado potato beetle larvae), caterpillars, thrips, leafhopper, and more

Appearance: **Rough stink bug** adults have a uniform brownish gray color, with a roughened appearance, and the presence of a "tooth" on each side of the face and a row of spines on the shoulder area. They are often confused with the invasive pest brown marmorated stink bug. **Spined soldier bug** adults are brown with lighter undersides, pointed shoulders, and an elongated, pointed abdomen. Older nymphs are tan to orange with red and white stripes on the abdomen. **Twospotted stink bug** adults have two black markings above the head and a "keyhole" shape on its wing covers. Nymphs are pale yellow or reddish-orange with black markings. Prey of all three species is consumed through a thick stylet (straw-like mouthpart).

Predacious Lifestage(s):
Nymphs in stages 2-5, Adult

Life Cycle:

- Egg | Nymph (5 stages) | Adult
- Overwinter as adults in leaf litter and other protected areas, but are sensitive to extreme cold winters. They emerge in mid-spring and seek out prey. Females begin laying barrel-shaped, cream- to gray-colored eggs in early summer, in oval clusters of 10 to 70, glued to leaves or stems. Eggs hatch within 10 days, and only the first instar does not eat.
- One to three generations per year.

When and Where to Scout:

- Due to their large size, stink bugs can often be found by sight starting in mid-spring.
- Eggs start appearing by early summer, but look similar to pest stink bug eggs. Each beneficial egg has spiked projections around the top (which may require a 10x hand lens to see).

Value: Naturally occurring populations often are not numerous enough to overpower large populations of pests, especially in the spring. The rough stink bug is mostly a predator of insects but sometimes feeds on leaves.

Top Ways to Attract/Conserve:

- Learn to recognize the difference between predatory and pest stink bugs to avoid unnecessary insecticides. Most predatory stink bugs have a square or pointed shoulder, while pest stink bugs have a rounded shoulder.
- Maintain diverse habitat of grasses, forbs, shrubs, and trees on the farm edges for alternate prey and overwintering habitat.

Look-alikes: pest stink bugs (e.g. brown marmorated stink bug), leaf-footed plant bug, squash bug, assassin bug

Rough stink bug adult.
Stopbmsb.org

Unlike pest species that may look similar, spined soldier bug adults have a distinctive dark line on the membranous tip of each forewing that may form one dark streak when the wing tips overlap.
Kansas Department of Agriculture , Bugwood.org

Spined soldier beetle nymphs and eggs.
Adam Sisson, Iowa State University, Bugwood.org

Spined soldier beetle nymph.
Phil Sloderbeck, Kansas State University, Bugwood.org

Twospotted stink bug adult.
Whitney Cranshaw, Colorado State University, Bugwood.org

Twospotted stink bug nymph and adult feeding on prey. Vladimir Neimorovets Macroid

MANTIDS (PRAYING MANTIS, PRAYING MANTID)

Around 20 species in the family Mantidae N-A: 10-127 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: Wide variety, including aphids, bees, beetles, butterflies, grasshoppers, moths, and wasps

Appearance: Adults are green or brown and have distinctive, spiny raised front legs, triangular head, and an elongated body. They can turn their heads 180° to see their prey.

Predacious Lifestage(s):
Nymph, Adult

Life Cycle:

- Egg | Nymph (5 stages) | Adult
- Overwinter as hardened masses of eggs glued to plant stems, branches, or structures. Eggs hatch in mid to late spring and nymphs feed on each other until dispersal for other prey.
- 1 generation per year.

When and Where to Scout:

- Mantids lie in wait for their prey, so they may not be noticed unless you shake plants or branches over paper or a cloth tray.
- They are often found lying in wait near flowers.
- Nymph activity starts in late spring, with adults present by mid-summer.

Value: Not valuable in reducing pest populations because they feed indiscriminately, take long breaks between feeding, and do not actively search out prey. Lately, the most common mantid found is the Chinese mantid due to releases from commercial sources.

Top Ways to Attract/Conserve:

- Mantids living amongst flowering plants are more robust and lay more eggs than those within non-flowering plants.

Look-alikes: none

Mantid egg case.

European mantid eating a grasshopper.
Whitney Cranshaw, Colorado State University, Bugwood.org

Newly hatched mantid nymphs.
Whitney Cranshaw, Colorado State University, Bugwood.org

Praying mantid.

Praying mantid eating a bee.

Mantid adult.

HORNETS AND YELLOWJACKETS

Aerial Yellowjacket (*Dolichovespula arenaria*) ..... A: 15-20 mm long
Baldfaced Hornet (*Dolichovespula maculata*)..... A: 25-40 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: several insects including caterpillars, flies, and other yellow jackets

Appearance: Baldfaced hornet adults are black with cream-white colored markings on the face, legs, and end of the abdomen. **Aerial yellowjacket** adults are blackish-brown with yellow markings on the face, legs, and end of abdomen. Nests of both species are covered with a papery shell, often built in trees or at roof peaks, and can grow to the size of a soccer ball by fall. Both species are defensive and sting or bite (aerial yellowjacket) when their nests are disturbed.

Predacious Lifestage(s):
Larva, Adult (chews prey to feed to larvae)

Life Cycle:
- Egg | Larva | Pupa | Adult
- Overwinter as fertilized queens in protected areas (e.g. hollow trees, rock piles, under bark, etc.)
- Queens emerge in spring and begin building a new nest. The nest expands quickly as workers develop and increase. Worker populations reach their peak in late summer to early fall. Then the colony begins to decline, males and queens mate, males die, and the fertilized queen seeks winter shelter. The deserted nest disintegrates in winter.
- Multiple generations per year.

When and Where to Scout:
- Adults can be seen from spring throughout the season.
- Adults are commonly seen searching plants for caterpillars and other prey.

Value: Both species are valuable in the biological control of many pest insects (especially caterpillars) in yards and gardens, but can become pests when nests are built near areas frequently used by humans or animals.

Top Ways to Attract/Conserve:
- Allow nests to remain in place until winter (nests are rebuilt each spring).

Look-alikes: yellowjackets, paper wasps, bees

Aerial yellowjacket.
Whitney Cranshaw, Colorado State University, Bugwood.org

Aerial yellowjacket.
Sean McCann

Baldfaced hornet adult.
Johnny N. Dell, Bugwood.org

Baldfaced hornet adult.
Joseph Berger, Bugwood.org

Baldfaced hornet larva.
Whitney Cranshaw, Colorado State University, Bugwood.org

Baldfaced horned nest.
Jerry A. Payne, USDA Agricultural Research Service, Bugwood.org

PAPER WASP

Native species in the genus *Polistes* and the European Paper Wasp (*Poliste dominulus*)

A: 15-25 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: caterpillars, beetle larvae, and larvae of flies, true bugs, and other wasps

Appearance: Adults are wasps with yellow or reddish markings that annually make open-celled paper nests. Paper wasps may be distinguished from yellowjackets by their more slender body (especially the waist area) and longer legs. Paper wasp nests are shaped like an upside down, open umbrella, are not covered by a papery envelope, and are usually hanging downward with open cells on the bottom. Nests are usually located hanging from eaves or ceilings of garages, barns, or sheds, but can sometimes found in aboveground hollows. Paper wasps can sting and aggressively defend their nests.

Predacious Lifestage(s):
Larva, Adult (chews prey to feed to larvae)

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter as fertilized queens in protected locations (e.g. under bark, in stumps and logs, within stacks of firewood, etc.)
- Queens emerge in spring and build a small paper nest where they lay their eggs. After 5-7 workers have developed, they rear the rest of the brood. The colony expands rapidly reaching maximum size in August and September. Then the colony begins to decline, males and queens mate, males die, and the fertilized queen seeks winter shelter. The deserted nest disintegrates in winter.
- Multiple generations per year.

When and Where to Scout:

- Paper wasp adults can be found as early as March or April and throughout the season.
- Adult wasps are commonly seen searching plants for caterpillars, beetle larvae, and other prey.

Value: Paper wasps are valuable in the biological control of many pest insects (especially caterpillars) in yards and gardens, but can become a pest when nests are built near areas frequently used by humans or animals.

Top Ways to Attract/Conserve:

- Construct a box shelter or reuse old birdhouses to provide nesting sites.
- Allow nests to remain in place until winter (nests are rebuilt each spring).

Look-alikes: yellowjackets, hornets, bees

Paper wasp adult with eggs and a new nest.
Gary Alpert, Harvard University, Bugwood.org

Paper wasp adult.
David Cappaert, Bugwood.org

Paper wasp life stages.
Whitney Cranshaw, Colorado State University, Bugwood.org

Paper wasp adult.
Joseph Berger, Bugwood.org

Paper wasp larva.
Joseph Berger, Bugwood.org

Paper wasp nest, larva, and adult.
Joseph Berger, Bugwood.org

TACHINID FLY

Over 1000 species occur in North America

A: 3-14 mm long 

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: adults and nymphs of true bugs; larvae of beetles, moths, and sawflies; grasshoppers

Appearance: Adult flies are bristly with dark hair, and about the size of a house fly. Eggs are white, oval, and flat, and can be found on the outside of the host body. Larvae are not seen, as they develop fully inside the host body. Tachinid flies are valuable parasitic insects and have a wider host range than parasitic wasps.

Predacious Lifestage(s):
Larva (endoparasitoid)

Life Cycle:

- Egg | Larva (3 stages) | Pupa | Adult
- Overwinters as a larva inside their host or as pupa in the soil. Larvae pupate in spring and flies emerge to feed on honeydew and nectar. Some tachinid species deposit eggs onto the host body while others lay them on the host's food, and the larva must find the host. Other fly species do not lay eggs at all, but instead lay live larvae on, in, or near the host.
- The larva then burrows inside the host body and feeds for 4 to 14 days. The larva then chews out of the host body, killing it in the process, and pupates nearby or in the soil.
- One or more generations per year.

When and Where to Scout:

- Watch flowers all season long to detect the presence of adults. The thick bristles covering most tachinid flies can be spotted as they flit between flowers.
- They may also be found feeding on honeydew from aphids or soft scales.
- When conducting regular pest monitoring, look for the small, creamy eggs glued on the outside of larval or true bug pests.

Value: Tachinid flies are the largest and most important group of insect parasitic flies. They are highly valuable in controlling insect pests; especially caterpillars and beetle larvae.

Top Ways to Attract/Conserve:

- Include season-long pollen- and nectar-producing plants near crops as an alternate food source for the adult flies, such as umbelliferous (dill, fennel, etc.) and composite (aster, goldenrod, coreopsis, etc.) flowers.
- Diversify crops on the farm.
- Allow aphid populations to persist in other areas of the farm to provide alternate prey and honeydew.

Look-alikes: house flies, small bees

Tachinid fly adult and its eggs on a hornworm.
R.J. Reynolds Tobacco Company Slide Set, R.J. Reynolds Tobacco Company, Bugwood.org

Adult tachinid fly visiting a flower.
Whitney Cranshaw, Colorado State University, Bugwood.org

Adult tachinid fly.
David Cappaert, Bugwood.org

Tachinid fly eggs on the head of a caterpillar.
Ken Chamberlain, The Ohio State University, Bugwood.org

Tachinid fly adult.
Joseph Berger, Bugwood.org

Tachinid fly eggs on the body of a beet armyworm.
Merle Shepard, Gerald R.Carner, and P.A.C Ooi, Insects and their Natural Enemies Associated with Vegetables and Soybean in Southeast Asia, Bugwood.org

FEATHER-LEGGED FLY

Trichopoda pennipes

A: 5-13 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: adult and nymph stages of true bugs such as squash bugs and stink bugs

Appearance: Adults are about the size of a housefly, with a black head, bright orange abdomen, and fringes of hairs on the hind legs. This is one of many species of tachinid flies whose larvae feed inside their prey. A field survey in California showed that 50% of squash bugs are typically parasitized by this fly.

Predacious Lifestage(s):
Larva (endoparasitoid)

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter as a single larva inside the host body. Larvae pupate in early spring, and emergent flies seek out floral nectar. After mating, females lay a single egg on up to 100 prey, and the hatched larva burrows inside to feed. The host remains alive and feeding during the larval growth inside it.
- After about 2 weeks, the single larva emerges, killing the host in the process, and then drops to the ground and pupates.
- Up to 3 generations.

When and Where to Scout:

- Flies that emerge in early spring may be seen seeking out nectar on flowers. At this time of year, they lay eggs on other overwintering bugs which may still be emerging.
- Look for squash bugs with eggs on them during the fly's second generation, starting in early summer.
- Use beating trays to find squash and stink bugs, and use a 10x hand lens to detect eggs near the top of the head.

Value: Because the fly's life cycle does not match squash bugs and it is not efficient at finding its host, the feather-legged fly plays only a minor biocontrol role for squash bugs.

Top Ways to Attract/Conserve:

- Provide a constant nectar source for the flies throughout the season, but especially in early spring, such as globe gilia, bluebells, or *Phacelia* sp. Late-season sources include plants in the Asteraceae family.
- Maintain undisturbed areas of the farm for overwintering purposes.

Look-alikes: house fly, small bees

Feather-legged fly adult.

Feather-legged fly pupal case (left) and egg on the underside of a squash bug.

Feather-legged fly eggs on squash bug nymphs.
Whitney Cranshaw, Colorado State University, Bugwood.org

Feather-legged fly adult.
Russ Ottens, University of Georgia, Bugwood.org

Feather-legged fly adult.
Charles Ray, Auburn University, Bugwood.org

Feather-legged fly adult.
Joseph Berger, Bugwood.org

PARASITOID WASPS - GENERAL

Many species in the families:
Braconidae, A: 1-18 mm long
Chalcidoidea, A: 2-18 mm long
and Ichneumonidae A: 3-50 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: aphids, caterpillars, leafminers, sawflies, true bugs, weevils, and wood-boring beetles

Appearance: Parasitoid wasp adults range in size from the head of a pen to several inches, with cream to black coloration. The wasp species are in general, specific to one insect host species. Their larva requires an insect host for development and pupation. The larva may feed inside the host (endoparasite) or outside the host (ectoparasite).

Predacious Lifestage(s):
Larva (endo- or ectoparasite)

Life Cycle:

- Egg | Larva (3 stages) | Pupa | Adult
- Overwinters as a single larva or pupa inside its host, emerging as an adult in early to mid-spring. Females use cues to find their prey, and lay one or more eggs inside each insect. As the larvae feeds, the host insect continues to grow. Once fully developed (1-2 weeks), the larva pupates either inside or outside the host, and then emerges as an adult.
- 1 or more generations per year.

When and Where to Scout:

- Watch flowers for visiting wasps starting in mid to late spring.
- When practicing regular scouting, watch for parasitized insects, such as aphids (bloated and tan or black) or caterpillars (shriveled).
- On aphids, for example, when 80% of aphids are parasitized, the parasitoid and aphid populations are balanced.

Value: With more than 65,000 species worldwide, parasitic wasps are the most important group of natural enemies of pest insects. They have a high reproductive rate and are often able to prevent economic injury from some pests.

Top Ways to Attract/Conserve:

- Adult wasps require nectar and pollen to survive. Provide a constant source of plants with shallow flowers (such as those in the carrot, aster, or mint families) in insectary strips throughout the farm.
- Diversify crops on the farm.
- Woody edge habitat has been shown to increase abundance of parasitoid wasps.

Look-alikes: tiny bees, flying ants

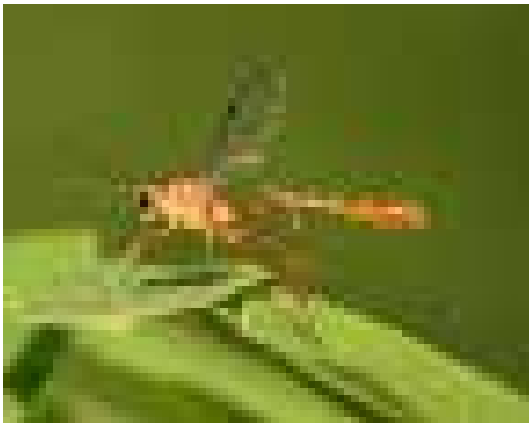
Braconid wasp cocoons on tomato hornworm.
Chazz Hesselein, Alabama Cooperative Extension System, Bugwood.org

Chalcid wasp (Phasgonophora sulcata).
Whitney Cranshaw, Colorado State University, Bugwood.org

Ichneumonid wasp adult.
Tony Wills

Braconid wasp (Syngaster lepidus).
Dong-Hwan Choe, University of California, Bugwood.org

Chalcid wasp.
Charley Eiseman, Bugguide.net



Ichneumonid wasp.
Muhammad Mahdi Karim

PARASITOID WASP ON APHID

Aphidius spp. A: 1.5-3 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: most aphid species have wasp species that parasitize them

Appearance: A group of parasitizing braconid wasps that are highly effective in controlling aphids. They are similar in appearance to a small black ant with wings, but have long, thin antennae. Their abdomen may be striped yellow to brown. Because larvae and pupae develop inside the aphid, they are not visible.

Predacious Lifestage(s):
Larva (endoparasitoid)

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter inside their dead aphid hosts in plant debris. Adults emerge in spring, and females find aphids by sensing plant defense and honeydew volatiles. They lay a single egg inside up to 300 aphids.
- The wasp larva feeds on the aphid contents for 5-12 days. After about 7 days, parasitized aphids stop feeding, become affixed to the leaf, and swell with the pupating wasp inside. The adult wasp creates a circular hole and crawls out the aphid abdomen.
- Multiple generations per year.

When and Where to Scout:

- Starting in mid-spring, look for immobile, bloated, tan to black aphid "mummies."
- Aphids with round exit holes towards the rear of the abdomen indicate emergence of the wasp.

Value: These are highly beneficial insects contributing greatly to keeping aphid populations in check due to their high egg-laying ability and quick generation time.

Top Ways to Attract/Conserve:

- Adults require pollen and nectar to survive (see pages 7-9 for a list of plants).
- Allow some aphids to survive to build up the population.

Look-alikes: winged ants, other small wasps

Aphidius sp. adult.
David Cappaert, Bugwood.org

Parasitized aphids stop feeding and become immobile"mummies." David Cappaert, Bugwood.org

Aphidius colemani aphid parasitoid and aphid mummy. David Cappaert, Bugwood.org

Parasitized aphid mummy (right) next to an unparasitized aphid (left). David Cappaert, Bugwood.org

Female *Aphidius* sp. lay a single egg in up to 300 aphids. David Cappaert, Bugwood.org

After the larva develops, it pupates inside the aphid and emerges through a round exit hole.
David Cappaert, Bugwood.org

PARASITOID WASP ON CODLING MOTH

Ascogaster quadridentata

A: 3-5 mm long
L: 2-3 mm long

Plants Benefited: Fruit

Prey: codling moth

Appearance: *Ascogaster quadridentata* is native to Europe, and was accidentally introduced to North America in shipments of fruit. Adults are tiny (3 to 5 mm) brown to black braconid wasps with long antennae. Larvae develop inside the living host and when ready, exit the caterpillar and spin a glossy white cocoon about 3 mm in length.

Predacious Lifestage(s):
Larva (endoparasite)

Life Cycle:

- Egg | Larva (4 stages) | Pupa | Adult
- Overwinters as a single immature larva inside its codling moth host. In spring, when overwintering codling moth larvae begin to develop into the pupal stage, the wasp larva will consume its host and emerge as an adult around full bloom of Red Delicious apples.
- Female wasps then seek out and lay a single egg inside up to 50 codling moth eggs. When the codling moth egg hatches, the first instar *A. quadridentata* larva is inside, and remains inactive until the codling moth larva leaves the fruit and seeks a cocoon site. The parasitoid then develops and then pupates inside the host, killing it upon exiting as an adult wasp.
- 2 or more generations per year.

When and Where to Scout:

- Parasitized larvae occur within apples or pears, making it difficult to determine the presence of *A. quadridentata.*
- Cut a sampling of infested fruit open to observe larvae. Parasitized codling moths are smaller than healthy ones.

Value: *A. quadridentata* is an efficient natural enemy because it is a strong flier, easily finds codling moth eggs, and its life cycle is synchronized with that of codling moth. In unsprayed trees, approximately 40% of codling moth eggs will be parasitized.

Top Ways to Attract/Conserve:

- Adult wasps require nectar, and parsnips have been shown to support the greatest numbers of wasps.
- Highly sensitive to insecticides.

Look-alikes: other tiny wasps

Ascogaster sp. adult.
MJ Hatfield

Ascogaster sp. adult.
MJ Hatfield

Ascogaster sp. adult.
H. Dumas, Wikimedia Commons

Ascogaster sp. adult parasitizing a codling moth egg. USDA-ARS, Wapato, WA

Ascogaster wasp adult parasitizing a codling moth egg. J. Brown, Washington State University

Ascogaster quadridentata adult.
Washington State Department of Agriculture

PARASITOID WASP ON LEAFROLLERS

Colpoclypeus florus

A: 2 mm long
L: 1-4 mm long

Plants Benefited: Fruit and Ornamental

Prey: most leafroller caterpillar species

Appearance: *C. florus* adult are wasps with short antennae and brown and black bodies. Their underside has two small dark spots at the base of the ovipositor. Eggs are slim, slightly curved, and less than 1 mm in length, and laid in clusters on the surface of the host caterpillar body. Larvae feed on the outside of the host, and stand out with their bright green coloring. Pupae are webbed onto the host caterpillar, and are light brown to nearly black.

Predacious Lifestage(s):
Larva (ectoparasite)

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter as larvae webbed onto the body of their host. After pupation, adults emerge in mid-spring. Females search for mature leafroller larvae that have already formed webbing in a rolled leaf. She lays up to 50 eggs in this shelter, where the larvae will attach to the outside of caterpillar, devouring it over a period of 15 days.
- Up to 2 generations per year.

When and Where to Scout:

- Starting in late spring and throughout summer, look for dense webbing (3 to 4 times thicker than the leafroller's body) within leafroller shelters (rolled leaves).

Value: *C. florus* are highly sensitive to pesticides, but can parasitize up to 80% of leafroller larvae in unsprayed orchards.

Top Ways to Attract/Conserve:

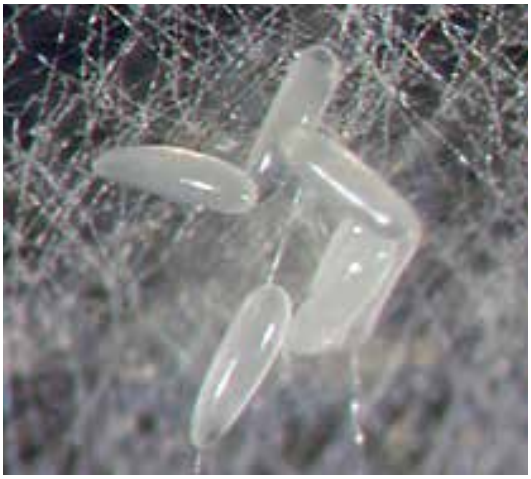
- Maintain diverse groundcover to allow for shelter and pollen and nectar for adults.
- Highly sensitive to insecticides.

Look-alikes: other tiny wasps

A leafroller caterpillar parasitized by larvae of Colpoclypeus florus. Stephen Ausmus, USDA-ARS

Colpoclypeus florus adult.
E. Beers, May 2000

Colpoclypeus florus female laying an egg on the outside of a leafroller larva. Stephen Ausmus, USDA-ARS



Colpoclypeus florus eggs.
E. Beers, May 2000

Colpoclypeus florus pupae with dead leafroller.
J. Brunner

PARASITOID WASP ON PEAR PSYLLA

Trechnites insidiosus/T. psyllae

A: 1 mm long
L: 1.5 mm long

Plants Benefited: Fruit

Prey: pear psylla

Appearance: This minute parasitic wasp is the primary parasitoid of pear psylla, and is commonly found throughout western North America. Trechnites insidiosus is the native western species, and T. psyllae is the European species that also occurs in the West. The 1 mm-long adult wasp has a black body, yellow legs, and an iridescent blue patch on the back.

Predacious Lifestage(s):
Larva (endoparasite)

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter as a single larva within a dead pear psylla mummy. Adults emerge at pear bloom stage, and females insert a single egg within the pear psylla nymph. Within 20 days, the wasp larva devours the psylla's internal organs, turning it into an immobile mummy. After pupation, the adult wasp emerges from the psylla body through a hole cut in the back.
- 3 to 4 generations per year.

When and Where to Scout:

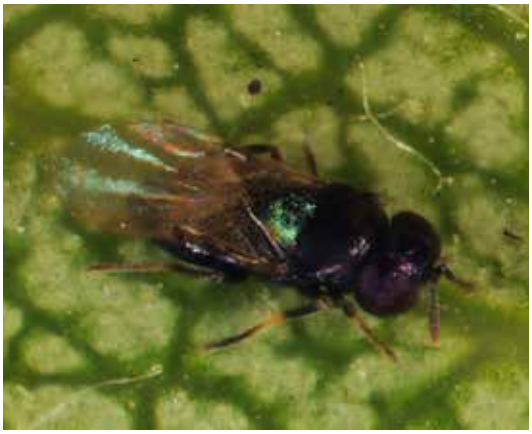
- *Trechnites* are incredibly difficult to monitor due to their minute size and parasitic nature. Observing the immobile mummies of parasitized pear psylla on the undersides of leaves is the only efficient method of monitoring their activity.

Value: *Trechnites* are highly valuable in organic orchards, where the wasps are known to parasitize 70 to 90% of the pear psylla population, with a season-long average of 50%.

Top Ways to Attract/Conserve:

- Maintain diverse groundcover to allow for shelter and pollen and nectar for adults.
- Highly sensitive to insecticides.

Look-alikes: other tiny wasps



Trechnites sp. adult.
E. Beers, May 2009

Trechnites psyllae adult laying eggs inside of a pear psylla nymph. M. Grbic

Pear psylla mummy parasitized by a Trechnites wasp. Washington State University

PARASITOID WASP ON STINK BUG EGGS

Trissolcus spp. A: 1-2 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: parasitize eggs of several sting bug species (some *Trissolcus* species target brown marmorated stink bug)

Appearance: Adults are tiny black wasps about the size of a gnat. Antennae are elbowed, abdomen is flattened, and wing veins are not obvious. Eggs, larvae, and pupae develop inside stink bug eggs that turn dark as the wasp develops.

Predacious Lifestage(s):
Larva

Life Cycle:
- Egg | Larva | Pupa | Adult
- Little is known about the overwintering behavior but some Trissolcus species are known to overwinter as adults.
- Female wasps lay one egg into each stink bug egg and will often remain near the egg mass to defend it from other wasps. A single wasp egg hatches inside stink bug eggs and larvae feed on the stink bug embryos. Eggs darken as the wasps mature inside, eventually emerging through a hole they cut in the top of the egg. Male and female wasps emerge and mate.
- Multiple generations per year.

When and Where to Scout:
- Look for parasitized stink bug eggs (which will be dark or have a hole at the top) throughout the season.
- When stink bug eggs are found, look for a tiny black wasp protecting the egg mass.

Value: *Trissolcus* species may be the primary biological control option for the invasive brown marmorated stink bug (BMSB). *T. japonicas* attacks eggs of BMSB (and possibly other stink bugs) and is able to parasitize up to 90% of BMSB eggs. Other *Trissolcus* species are being researched for their potential control of BMSB. *Trissolcus* species found parasitizing BMSB eggs in Utah include *T. utahensis* and *T. euschisti*.

Top Ways to Attract/Conserve:
- Leave parasitized stink bug egg masses intact to promote population increase of wasps.
- Provide a continuous source of blooms with shallow nectar reserves to attract adult wasps.

Look-alikes: gnats

Trissolcus japonicus adult emerging from a BMSB egg. Christopher Hedstrom, USDA APHIS Quarantine Facility, Corvallis, Oregon

Trissolcus japonicus adult.
Elijah Talamas, USNM

Trissolcus basalis adult parasitizing stink bug eggs.
Guido Bohne, Bugwood.org

Trissolcus halyomorphae adults on BMSB eggs found in Utah.

Trissolcus utahensis adult found in Utah.

Trissolcus euschisti adult found in Utah.

PARASITOID WASP ON WOOLLY APPLE APHID

Aphelinus mali A: 0.6-1.4 mm long

Plants Benefited: Fruit and Ornamental

Prey: woolly apple aphid

Appearance: Adult wasps are slightly smaller than their host prey and black in color with short antennae. Although they have wings, they prefer to jump, making them difficult to spot.

Predacious Lifestage(s):
Larva (endoparasite)

Life Cycle:

- Egg | Larva (4 stages) | Pupa | Adult
- Overwinter as a single larva inside the dead carcass of a woolly apple aphid host. Wasps emerge in spring when woolly apple aphid nymphs start to become active. Females lay a single egg in the undersides of up to 70 aphids. Larvae feed inside the aphids for up to 12 days before pupating and emerging through a hole cut in the back of the dead aphid mummy.
- 6 to 7 generations per year.

When and Where to Scout:

- Starting in late spring and throughout the season, look for immobile, black woolly apple aphid mummies within aphid colonies.
- Mummies are most obvious in the fall after the woolly apple aphids have migrated to overwintering locations (roots and tree cracks and crevices).

Value: In average or cold winters (not mild), *A. mali* wasps can control most populations of woolly apple aphids in unsprayed trees. In managed orchards, these wasps are not as important as lacewing or syrphid fly larvae in controlling woolly apple aphids.

Top Ways to Attract/Conserve:

- Adults require pollen and nectar, and plants such as alyssum and buckwheat have been shown to help maintain populations.
- Maintain leaf litter as shelter for the wasps.

Look-alikes: other tiny wasps

Aphelinus mali adults with woolly apple aphids.
Angelica Cameron, bugsforbugs.com

Aphelinus mali adult.
Frank Peairs, Colorado State University, Bugwood.org

Aphelinus mali attacking an aphid.
joakinmg.wordpress.com

Woolly apple aphids parasitized by *Aphelinus mali*. Angelica Cameron, bugsforbugs.com

Woolly apple aphids colony with a mixture of parasitized and live aphids.

Aphelinus mali attacking an aphid.
Elizabeth Beers, WSU

PTEROMALID WASP

Family: Pteromalidae A: 1-5 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: primarily larvae of butterflies, moths, and beetles (including bark beetles). May also feed on aphids, flies, leafhoppers, mealy bugs, planthoppers, sawflies, and scales

Appearance: Adults are minute wasps, typically metallic green, blue, or black in color.

Predacious Lifestage(s):
larva (endo- or ectoparasite)

Life Cycle:

- Egg | Larva | Pupa | Adult
- Most species overwinter as a mature larva within a cocoon. Some species spend 2 years as a larva, while others take a few weeks.
- Female wasps lay their eggs on or within the host, from which more than 100 wasps may emerge.
- Unknown number of generations per year in Utah.

When and Where to Scout:

- Look for pest larvae that turn brown as pteromalid wasps develop inside throughout the season.
- Adults can be found near plants that attract their hosts.

Value: Pteromalid wasps include species that are important parasites of sawflies.

Top Ways to Attract/Conserve:

- Adults feed on nectar and pollen. Provide a constant source of composite flowers (such as sunflowers, daisies, and chamomile) in insectary strips throughout the farm.
- Increase crop diversity on farms or in gardens.
- Highly sensitive to insecticides.

Look-alikes: gnats

Pteromalid wasp adult female.
Gerald J. Lenhard, Louisiana State University, Bugwood.org

Pteromalid wasp adult male.
Gerald J. Lenhard, Louisiana State University, Bugwood.org

Pteromalid adult wasp searching for a bark beetle host. Erich G. Vallery, USDA Forest Service - SRS-4552, Bugwood.org

Pteromalid wasp adult and exit holes on pupal host. Sturgis McKeever, Georgia Southern University, Bugwood.org

Pteromalid wasp adult.
Johnny N. Dell, Bugwood.org

Pteromalid was adult on larval host.
Sturgis McKeever, Georgia Southern University, Bugwood.org

TIPHIID WASP

Family: Tiphiidae
Most common genera in North America: *Myzinum*, *Tiphia*

A: 6-26 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: white grub larvae (Japanese beetle, June beetles)

Appearance: Adults are tiny wasps, often black, with yellow or red markings, and may resemble yellowjackets or other hunting wasps. Males have an up-curved hook at the tip of the abdomen.

Predacious Lifestage(s):
Larva (ectoparasite)

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter as full-grown larva inside a cocoon in the soil
- Female adults look for beetle grub in the ground. The female wasp deposits her egg on the grub abdomen. As the wasp larva develops, the beetle larva becomes partially paralyzed until the wasp larva completely consumes it. The larva then constructs a cocoon for overwintering. Wasps emerge in the spring.
- One generation per year.

When and Where to Scout:

- Male adults are known to congregate on vegetation early in the morning when temperatures are low.

Value: Tiphiid wasps can be economically important in the control of turf grubs and have been used as a biological control of the invasive Japanese beetle.

Top Ways to Attract/Conserve:

- Adults feed on nectar and pollen. Provide a constant source of plants with shallow flowers (such as those in the carrot, aster, or mint families) in insectary strips throughout the farm.
- Highly sensitive to insecticides.

Look-alikes: yellowjackets, other hunting wasps

Tiphiid wasp (Myzinum sp.) adult.
Johnny N. Dell, Bugwood.org

Tiphiid wasp (Myzinum quinqucincta) adult.
Fitz Clarke, Bugwood.org

Tiphiid wasp (Tiphia sp.) adult.
Howard Ensign Evans, Colorado State University, Bugwood.org

Tiphiid wasp egg (inside the black circle) on an oriental beetle.
Mike Reding and Betsy Anderson, USDA ARS, Bugwood.org

Oriental beetle parasitized by Tiphiid wasp (Tiphia vernalis); note the larva inside the black circle.
Mike Reding and Betsy Anderson, USDA ARS, Bugwood.org

Oriental beetle parasitized by Tiphiid wasp (Tiphia vernalis); note the larva on the right side of the larval body. Mike Reding and Betsy Anderson, USDA ARS, Bugwood.org

TRICHOGRAMMA WASP

Family: Trichogrammatidae A: 1 mm long

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: eggs of hundreds of species especially moths, sawflies, and butterflies

Appearance: Adults are a minute yellow wasp with red eyes. Eggs are deposited into the host egg. Larvae and pupae develop inside the host egg which will turn black when the pupa is nearly ready to emerge.

Predacious Lifestage(s):
Larva (endoparasite)

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter as pupae inside the host eggs. Adults emerge in the spring, and females lay a single egg inside a recently laid host egg. The wasp larva hatches and consumes the host egg embryo as it develops and eventually becomes a pupa that will emerge from the host egg as an adult.
- Multiple generations per year.

When and Where to Scout:

- Adults are difficult to spot with the naked eye, but may be found on blooms throughout the growing season with shallow nectar reserves such as plants in the carrot, legume, aster, and mint families.

Value: *Trichogramma* wasps alone may not be able to suppress plant damage to acceptable levels, but they contribute to the overall biological control of pest insects.

Top Ways to Attract/Conserve:

- Provide a continuous source of blooms with shallow nectar reserves to attract adults.
- Establish permanent plantings (for example hedgerows) of flowering plants.
- Increase crop diversity on farms or in gardens.
- Highly sensitive to insecticides.

Look-alikes: gnats

Trichogramma wasp adults attacking eggs of a leafroller pest. E. Beers, Washington State University

Codling moth egg parasitized by Trichogramma sp.; note the exit hole in the codling moth egg.
Washington State University

Trichogramma wasp nymph recently emerged from a host egg. Charley Eiseman, bugguide.net

Trichogramma wasp adult on host egg.
Peggy Greb, USDA Agricultural Research Service, Bugwood.org

Trichogramma wasp adult on host egg.

Trichogramma wasp adult on host egg.
USDA

INSECT PATHOGENS

Fungi, bacteria, and viruses

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: all insects are susceptible to attack

Appearance: Thousands of microbial organisms representing fungi, bacteria, and viruses can attack insects. Some kill them immediately while others cause long-term effects, such as reduced reproductive capacity. Some insect species have fluctuating pathogenic attacks (epidemics) that cause their populations to rise and fall over the years.

Types of Pathogens:

- **Viruses** are submicroscopic organisms that only survive inside their host. Caterpillars are most commonly attacked, and are killed within a week. Once dead, their body releases millions of virus particles protected in "occlusion bodies." The virus may be spread from adult to offspring, or when an insect encounters an occlusion body. Commercial virus products for fruit/vegetable pests include codling moth, beet armyworm, and tobacco budworm.
- **Bacteria** are single-celled organisms. *Bacillus* is the most commonly occurring genera used to kill insects. It produces toxins that attack the digestive system of feeding insects, causing death within a few days. *B. thuringiensis* (Bt) is the most important bacterium in pest control, with thousands of strains specific to certain insects. Dozens of Bt biopesticide products are available commercially for caterpillars, beetles, flies, and mosquitoes.
- **Fungi** are multi-cellular organisms consisting of a mass (mycelium) of thread-like hyphae and reproductive spores. They are important pathogens of aphids, leafhoppers, and whiteflies. Insects killed by fungi remain attached to the plant, allowing effective release of spores to infect other insects. A few biopesticides are available from fungi, but for the most part, they require moist conditions for spread.

Value: Insect pathogens are highly important in the control of pests of undisturbed habitats and field crops. Their natural biocontrol is limited in fruits and vegetables due to specific environmental requirements for infection. Instead, many effective biopesticides have been created from naturally occurring insect pathogens.

Beet armyworm killed by nuclear polyhedrosis virus. David Nance, USDA Agricultural Research Service, Bugwood.org

Cabbage looper killed by spinosad (made from metabolites of a soil bacterium).

Colorado potato beetle infected with Beauveria bassiana. www.potatobeetle.org

Brown marmorated stink bug infected with a fungal pathogen. UMD.edu

Western tarnished plant bug killed by Beauveria bassiana. UC Davis

Currant borer larva killed by fungal pathogen.

PARASITIC NEMATODES ON GRUBS

Many species in the families Steinernematidae and Heterorhabditidae

Plants Benefited: Fruit, Vegetable, and Ornamental

Prey: primarily soil-dwelling beetles, caterpillars, flies (maggots and pupae), and thrips (pupae)

Appearance: Nematodes are microscopic, worm-like organisms that occur in the soil. There are hundreds of species, some scavengers, some plant-parasitic, and some that feed on insects. They occur in the top few inches of the soil, and some insect parasitic nematodes are active hunters. To survive, they require a moist environment. Often, nematodes are purchased and released.

Predacious Lifestage(s):
All stages

Life Cycle:

- Overwinters in the soil in various stages. Juvenile nematodes locate a suitable host by ambushing or by seeking them out. They enter the host through its natural openings, and then release gut bacteria that are pathogenic to the insect. The bacteria multiply, and the insect dies within 1 to 2 days. The nematodes inside the insect feed on the bacteria and the insect tissues.
- Adults then mate and lay eggs inside the dead insect, and 3 to 4 generations may occur within each insect. Thousands of juveniles will eventually exit to seek out new hosts.
- Multiple generations per year.

When and Where to Scout:

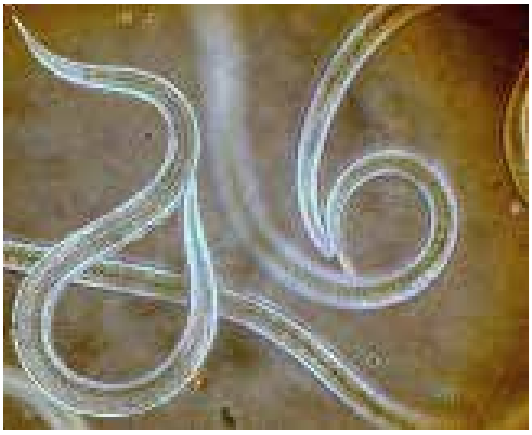
- They cannot be seen with the naked eye, and insects that are killed, are beneath the soil.
- In fruit and vegetable production, look for pests that nematodes could be used to control, such as cutworms, root weevil larvae, and June beetle larvae.

Value: Because they cannot be seen with the naked eye, the benefits of native nematode populations are difficult to measure. Beneficial nematodes are primarily used to augment the native population, and are sold in wettable clay powder packages which hold several million active units each.

Top Ways to Attract/Conserve:

- If applying purchased nematodes, immediate release is ideal; however, nematodes may be refrigerated at 40°F for several months.
- After application, ensure that the soil remains wet for at least 2 hours following application. Nematodes can be killed if soil surface temperature is above 85°F.

Look-alikes: none



Microscopic view of entomopathogenic nematodes. David Cappaert, Bugwood.org

Entomopathogenic nematodes attacking western flower thrips. R. Buitenhuis, Vineland

Thousands of nematodes from inside a grub cadaver which can be placed in orchard or greenhouse soil for biological control of pests.
Peggy Greb, USDA

Grub infested with entomopathogenic nematodes.
Purdue University

White grub larva killed by entomopathogenic nematodes next to two healthy larvae.
Whitney Cranshaw, Colorado State University, Bugwood.org

Two white grub larvae killed by entomopathogenic nematodes next to two healthy larvae.
Whitney Cranshaw, Colorado State University, Bugwood.org

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Rulers in Millimeters and Inches

EXTENSION

UtahStateUniversity